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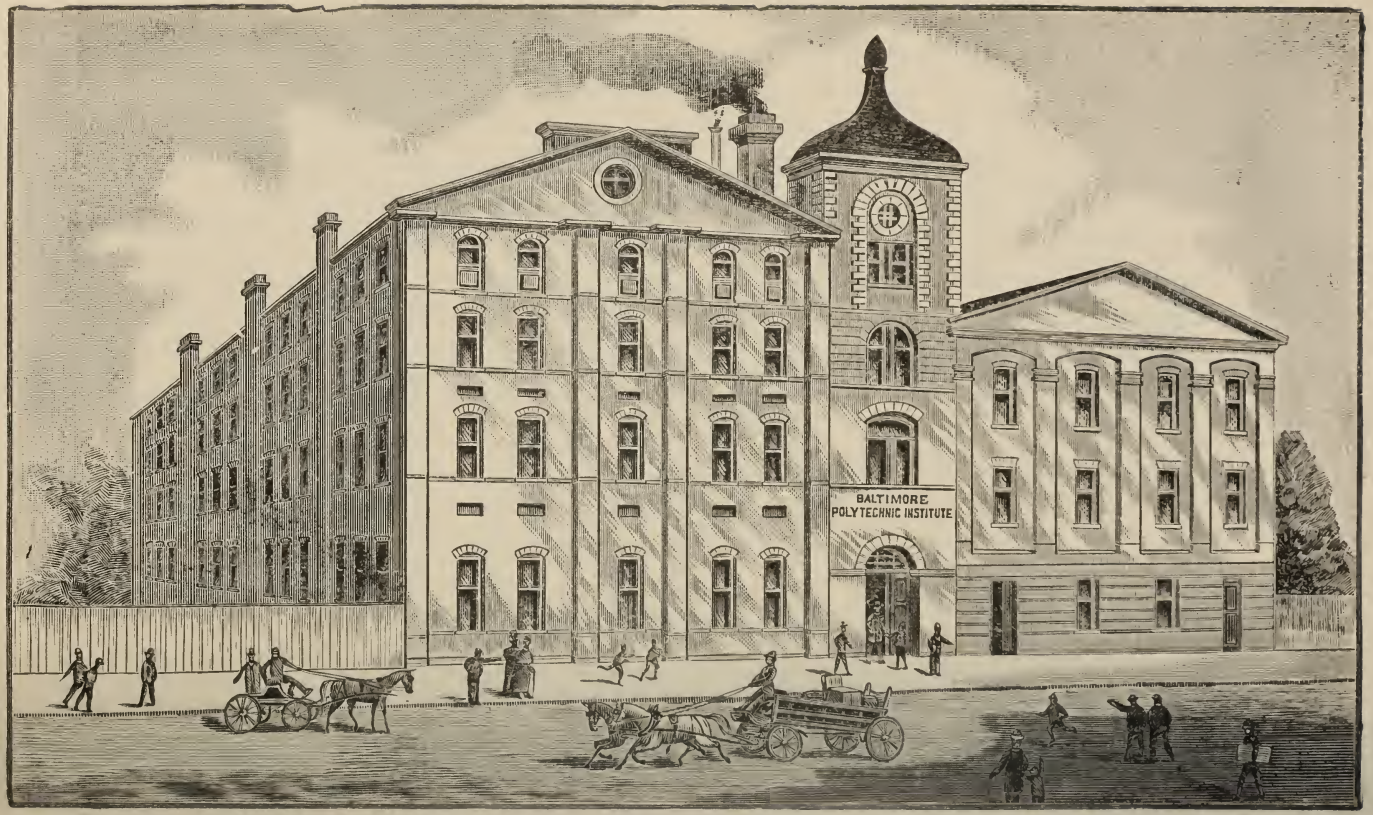

NEW BUILDING. OLD BUILDING.

ANNUAL REGISTER

— OF THE —

BALTIMORE POLYTECHNIC INSTITUTE

311-331 COURTLAND STREET.

NINETEENTH ACADEMIC YEAR.

1903-1904.

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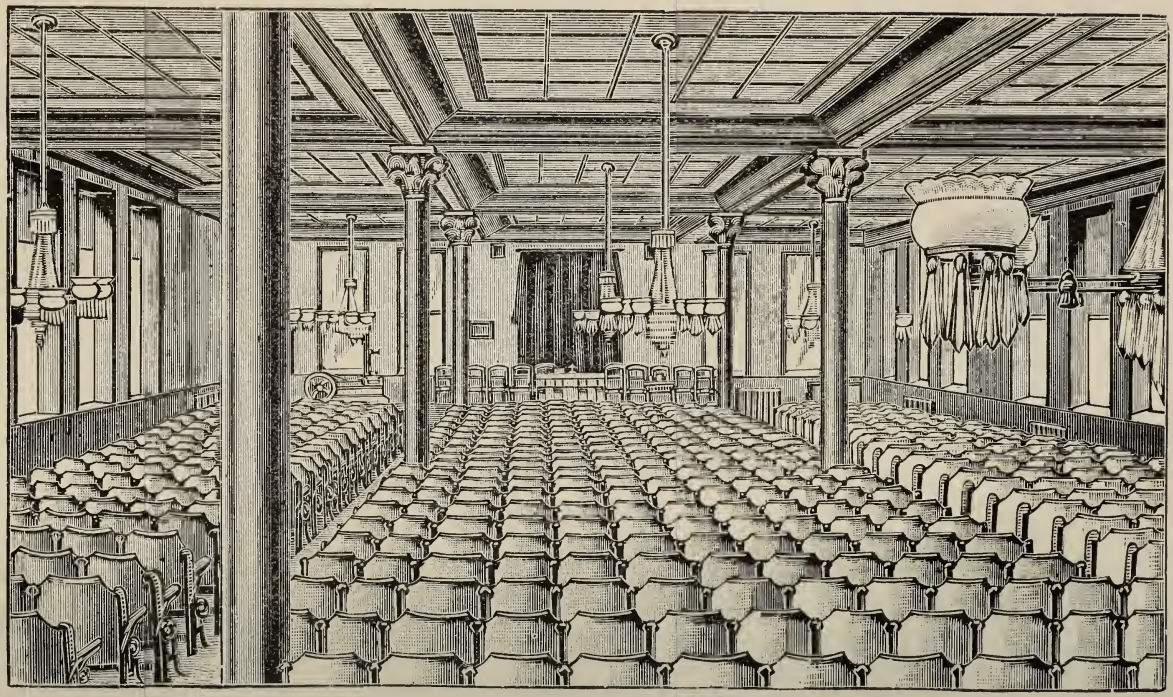

THE ASSEMBLY ROOM.

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BALTIMORE POLYTECHNIC INSTITUTE.

HISTORICAL SKETCH.

The Baltimore Polytechnic Institute, the second manual training school established in the United States as part of a public school system, is one of the several educational institutions of the secondary grade maintained by the city of Baltimore.

Although it is believed that tentative efforts to engraft manual training upon the city's school system were made as early as 1873 or '74, yet the action which led to the establishment of this school was not taken until April, 1883. At a meeting of the Board of Commissioners of Public Schools, held on the 24th of that month, Mr. Joshua Plaskitt, Commissioner for the Ninth Ward, offered a resolution for the appointment of a committee "to consider . . . . the advisability of establishing a school or schools for manual training." The resolution was adopted, and the committee thus appointed recommended the establishment of a school "for manual education." The necessary enabling ordinances and enactments having been passed by the City Council of Baltimore and the General Assembly of Maryland, the school was organized and opened on February 26, 1884, under the name "Baltimore Manual Training School," with Dr. Richard Grady as director.

In January, 1886, the faculty was reorganized, Lieut. John D. Ford, an officer of the Engineer Corps of the U. S. Navy, who had been detailed for duty at the school, becoming Principal.

From the opening of the school applicants for admission had been required to pass through the eighth grammar school grade, or to show satisfactory evidence of having had equal instruction; but in September, 1888, it was decided to admit

pupils of the 6th, 7th and 8th grammar grades. This action opened the school to so large a number of young boys that increased accommodations became imperative, and in June, 1890, the new building, devoted to the academic studies and drawing, was finished and occupied.

Lieut. Ford was recalled to the naval service in June, 1890, and was succeeded as Principal by John W. Saville, a retired member of the Engineer Corps of the Navy.

In May, 1893, the name of the school was changed to "Baltimore Polytechnic Institute," and the titles of Principal and Vice-Principal to President and Vice-President, respectively.

Mr. Saville resigned in August, 1899, and was succeeded as President by Lieut. William R. King, Engineer Corps, U. S. N., the present head of the school.

The new charter of Baltimore went into effect on March 1, 1900, and under one of its provisions it devolved upon the Mayor, Hon. Thomas G. Hayes, to appoint, as the head of the Department of Education, a Board of School Commissioners composed of nine persons, to serve without pay, and to be chosen from among those citizens he deemed "most capable of promoting the interests of public education, by reason of their intelligence, character, education, or business qualifications." The names of the distinguished citizens so chosen will be found on page 14.

Another provision of the Charter requires that, "in order to secure the continuance of local interest in, and oversight of the public schools, there shall be appointed by said Board of School Commissioners such number of unpaid School Visitors as may be found requisite." In pursuance of this provision there was appointed as a Board of Visitors to this institution, a group of gentlemen, some of whom are recognized in technical circles throughout the country as being at the head of their respective professions.

The members of the Board of Visitors had no sooner acquainted themselves with the general conditions prevailing in the school—the age and attainments of the pupils of the

lower grades, the character of the work done, and the scope of the curriculum—than they submitted to the Board of School Commissioners a very comprehensive and exhaustive report discussing the condition, needs, and aims of the school, and recommending certain changes in the requirements for admission, and in the curriculum. The partial adoption of this report in September, 1900, excluded grammar school pupils from the Institute, thus making the standard for admission the same as that for the City College.

In April, 1901, a further consideration of the report of the Board of Visitors led to the practical addition of one year to the course by permitting graduates to remain for a year of postgraduate work; and in May, 1902, the length of the course was, by action of the Board, set at four years for pupils entering on and after September 15, 1902.

It was further provided that pupils leaving the Institute before the completion of the course should receive certificates of the work done by them up to the time of their withdrawal.

By operation of the new Charter the titles of President and Vice-President were changed, in 1900, to Principal and Vice-Principal.

RECORD OF THE FACULTY AND STAFF,

FROM THE ORIGIN OF THE INSTITUTE TO DECEMBER 31, 1903.

The school was organized on February 26, 1884, under the name "Baltimore Manual Training School;" this name was changed in May, 1893, to "Baltimore Polytechnic Institute."

Richard Grady, M.D., D.D.S., Director, February 26, 1884. Services terminated January 11, 1886.

John D. Ford, P. A. Eng., U. S. N., Instructor in Drawing and Steam Engineering, February 26, 1884. Principal, January 11, 1886. Recalled to Naval Service, June 30, 1890.

William Dugent, Instructor in Wood Work, February 26, 1884. Transferred to Pattern Shop, January 11, 1886, and was in charge of that department until September 17, 1900.

J. H. W. Onion, Instructor in Pattern Department, March 1, 1884. Services terminated June 30, 1886.

A. Newton Ebaugh, First Assistant in Academic Department, January 11, 1886. Vice-President, May, 1893. Transferred to Baltimore City College, June 30, 1896, as Professor of History and Political Economy.

C. F. Friese, Instructor in Metal Department, September 1, 1886. Resigned to accept position in Chicago Manual Training School, June 30, 1891.

W. H. Hall, B.C.C., '85, Assistant Instructor in Physics and Chemistry, September 23, 1886. Instructor in Academic Department, June 7, 1898. Head of Department of Physics and Chemistry, September 13, 1899. Head of Department of Science, June 21, 1901.

William G. Richardson, Assistant Instructor in Machine Department, February, 1887. Instructor in Machine Work and Engineering Materials, September 13, 1899.

Andrew J. Pietsch, Assistant Instructor in Academic Department, September 1, 1887. Transferred to be Principal of Male Grammar School No. 4, September, 1890.

J. C. McSherry, Assistant Instructor in Academic Department, September, 1887. Resigned, April, 1888.

Richard Piez, B.M.T.S., '87, Instructor in Mechanical Drawing, September, 1887. Resigned, September, 1891.

Lawrence Griffith, Assistant to the Principal and Instructor in Freehand Drawing, September, 1887. Resigned, June, 1890.

John L. Yater, Assistant Instructor in Academic Department, September, 1888. Transferred to be Principal of Annex School No. 14, January, 1899.

Flavius J. Pennington, B.M.T.S., '87, Assistant Instructor in Wood Department, September, 1888. Resigned, April 1, 1889.

David G. Butterfield, Assistant Instructor in Academic Department, September 11, 1888. Transferred to be First Assistant in Male Grammar School No. 20, March 19, 1889.

Thomas G. Ford, B.M.T.S., '88, Assistant Instructor in Wood Department, October, 1888. Assistant Instructor in Carving and Pattern-making, September, 1897. Instructor in Pattern-making and Wood-turning, September 17, 1900, and, in addition, Assistant in Mechanical Drawing, September, 1902

John T. Robinson, Assistant Instructor in Sheet Metal Department, October, 1888. Resigned to become instructor in Sheet Metal Work at the Brooklyn Polytechnic Institute, Brooklyn, N. Y., June 30, 1894.

J. Ward Willson, M.D., B.C.C., '61, Assistant Instructor in Academic Department, March 21, 1888. Instructor in Academic Department, September, 1898. Instructor in History, Physiology, and German, September 16, 1901. Instructor in German, English, and Science, September, 1902.

George M. Gaither, B.M.T.S., '88. Assistant Instructor in Wood Department, April 1, 1889. Instructor in Carpentry and Carving, September 17, 1900.

Richard H. Uhrbrock, B.C.C., '86, Ph.B., I.W.U., '97, Assistant Instructor in Academic Department, May 15, 1889. Vice-President and Instructor in Mathematics, September, 1896. Head of Department of Mathematics, September 13, 1899. Vice-Principal, June 21, 1901.

John W. Saville, P. A. Eng., U. S. N. (retired), Principal and Instructor in Steam Engineering, September, 1890. President and Instructor in Steam Engineering, May, 1893. Resigned, August 31, 1899.

Edward S. Kines, B.C.C., '90, Assistant Instructor in Academic Department, September, 1890. Resigned, October 1, 1894.

J. Henry Laessig, Assistant to Principal and Instructor in Mechanical Drawing, September, 1890. Resigned, June 30, 1893.

Eason Lewis, Lieut. U. S. A., Instructor in Military Drill and Assistant Instructor in Academic Department, November, 1890. Recalled to U. S. Army, April, 1891.

Albert McClean, Instructor in Forge Work, September, 1891. Resigned, January, 1898.

Warren S. Seipp, B.M.T.S., '91, Instructor in Free-hand Drawing, September, 1891. Instructor in Free-hand Drawing and Carpentry, November, 1901. Instructor, Manual Training Centre No. 1, June, 1902. Instructor in Drawing, Carpentry, and Sheet Metal Work, September, 1903.

B. Wheeler Sweany, Instructor in Mechanical Drawing, September, 1892. Transferred to Baltimore City College as Professor of Drawing, October 1, 1897.

Joseph F. McBee, Assistant Instructor in Academic Department, September, 1893. Transferred to be Principal of Annex School No. 14, June, 1894. Re-transferred to the Baltimore Polytechnic Institute as Assistant Instructor in Academic Department, January, 1899. Dismissed, May, 1899.

Nathaniel D. D. Sollers, Assistant Instructor in Academic Department, September, 1893. Resigned, June, 1894.

F. D. J. Kaessmann, Assistant Instructor in Academic Department, September, 1893, until September, 1901.

William A. Jones, Assistant Instructor in Sheet Metal Department, September, 1894. Instructor in Sheet Metal Department, September, 1898. Instructor in Forge and Sheet Metal Work, September 17, 1900.

Samuel M. North, B.C.C., '87, Assistant Instructor in Academic Department, September, 1894. Instructor in Academic Department, September, 1898. Head of Department of English, September 13, 1899. Head of Department of English, including History and Language, June 21, 1901.

Joseph C. O'Connor, Assistant Instructor in Carpentry, September, 1894. Resigned, June 30, 1897.

Henry Sanders, Instructor in Sheet Metal Department, September, 1894. Resigned, November 30, 1894.

William S. Blake, B.C.C., '94, Assistant Instructor in Academic Department, October 1, 1894. Transferred to Male Grammar School No. 1, January, 1899.

Ralph L. Williams, B.P.I., '93, Assistant Instructor in Academic Department, October 1, 1894. Lost at sea, July 4, 1898.

Frederick W. Wild, Instructor in Sheet Metal Department from December 1, 1894, to September 17, 1900.

B. Harrison Branch, B.M.T.S., '92, Assistant Instructor in Academic Department and Assistant in Machine Department, October, 1896. Resigned, April, 1898.

Samuel P. Platt, Instructor in Mechanical Drawing and Descriptive Geometry, October 1, 1897.

J. C. Mattoon, B.M.T.S., '90, Assistant Instructor in Academic Department, November 1, 1897. Resigned, February, 1898.

Oliver Bacharach, B.C.C., '97, Assistant Instructor in Academic Department, April, 1898. Assistant Instructor in Mathematics, September 16, 1901.

William P. Gundry, B.M.T.S., '90, Assistant Instructor in Academic Department, April, 1898. Resigned, December 31, 1901.

J. Edward Broadbelt, Ph.G., B.M.T.S., '90, Assistant Instructor in Academic Department, September, 1898. Secretary and Assistant Instructor in Science, September 16, 1901.

John H. DeValin, Instructor in Forge Work from September, 1898, to September 17, 1900.

William R. King, Passed Assistant Engineer, U. S. N. (retired), U. S. N. A., '75, President and Instructor in Engineering and Applied Mechanics, September 1, 1899. Principal and Head of Department of Engineering, June 12, 1901.

John H. Bramble, B.C.C., '96, Assistant Instructor in Academic Department, October, 1899. Assistant Instructor in Mathematics and Science, September 16, 1901. Assistant Instructor in Mathematics, September 15, 1902.

John Montgomery Gambrill, B.P.I., '97, Instructor in History, Civics, and Literature, June 11, 1902.

Charles Ernest Conway, B.P.I., '02, Assistant in Department of Engineering and Applied Mechanics, June 11, 1902. At Lehigh University, 1903-4.

George P. Von Eiff, B.P.I., '02, Assistant in Department of Science, September, 1903.

William L. De Baufre, B.P.I., '03, Assistant in Departments of Engineering and Mathematics, September, 1903.

Irving L. Twilley, A.M., Instructor in Department of English, September, 1903.

BOARD OF SCHOOL COMMISSIONERS.

JOSEPH PACKARD, *President*,
DR. IRA REMSEN,
ALCAEUS HOOPER,
REV. WILLIAM ROSENAU,
CHARLES H. EVANS,
JAMES H. PHILLIPS,
COL. A. B. CUNNINGHAM,
THOMAS McCOSKER,
(One Vacancy.)

BOARD OF VISITORS.

ABRAM H. COLMARY, *Chairman*,
FREDERICK W. WOOD,
FREDERICK J. MAYER,
GUSTAVUS W. LEHMANN,
JAMES L. MURRILL,
WILLIAM H. ROTHROCK,
MENDES COHEN.

SUPERINTENDENT OF PUBLIC INSTRUCTION.

JAMES H. VAN SICKLE.

Calendar for School Year 1903-1904.

September 14, Monday	Opening of Session.
November 26, Thursday	Thanksgiving Day.
November 30, Monday	Second Quarter begins.
December 23, Wednesday	Christmas Vacation begins.
January 4, Monday	Christmas Vacation ends.
February 1 to February 12	Semi-annual Examinations.
February 15, Monday	Third Quarter begins.
February 22, Monday	Washington's Birthday.
March 28, Monday	Fourth Quarter begins.
March 31, Thursday	Easter Vacation begins.
April 4, Monday	Easter Vacation ends.
April ——	Arbor Day.
May 16, Monday	Annual Examinations begin.
May 30, Monday	Decoration Day.
June 14, Tuesday	Commencement Day.
September 13, Tuesday	Opening of Session.
November 24, Thursday	Thanksgiving Day.
November 28, Monday	Second Quarter begins.
December 23, Friday	Christmas Vacation begins.

FACULTY.

WILLIAM R. KING, U. S. N., *Principal*
and
Head of Department of Engineering.

RICHARD H. UHRBROCK, Ph.B., *Vice-Principal*
and
Head of Department of Mathematics.

WILLIAM H. HALL,
Head of Department of Science.

SAMUEL M. NORTH,
Head of Department of English, including History and Language.

STAFF.

JOHN WARD WILLSON, M.D.,
German, English Composition, and Science.

SAMUEL P. PLATT,
Mechanical Drawing and Descriptive Geometry.

OLIVER BACHARACH,
Mathematics.

JOHN H. BRAMBLE,
Mathematics.

JOHN EDWARD BROADBELT, Ph.G.,
Secretary and Science.

JOHN MONTGOMERY GAMBRILL,
History, Civics and Literature.

IRVING L. TWILLEY, A.M.,
English.

GEORGE P. VON EIFF,
Science.

WILLIAM L. DE BAUFRE,
Engineering, Mathematics, and Practice.

MECHANICAL DEPARTMENT.

WILLIAM G. RICHARDSON,
Machine Work and Engineering Materials.

THOMAS G. FORD,
Pattern-Making, Wood-Turning, and Mechanical Drawing.

WILLIAM A. JONES,
Forge and Sheet Metal Work.

GEORGE M. GAITHER,
Carpentry and Wood-Carving.

WARREN S. SEIPP,
Drawing, Sheet Metal, and Carpentry.

COURSE OF STUDY AND GENERAL STATEMENT OF PLAN AND PURPOSE.

The course of study for the Baltimore Polytechnic Institute is designed to accomplish the following purposes:

1. To give a sound fundamental education to pupils whose inclinations and other circumstances preclude a college course.

2. To give to youth that healthful and highly valuable manual training which broadens education, and conduces to dexterity, contrivance, and invention.

To this end the time usually devoted to Greek and Latin is employed, during two years of the course, in carpentry, sheet-metal, and light forge exercises. These exercises cover what is known as Manual Training, and are given with special reference to their educational value.

3. To give to students in the third and fourth years such studies in Mathematics, Physics and Chemistry, and such mechanical exercises in Applied Manual Training as will fit them:

(*a*) For teaching in Manual Training Schools.

(*b*) For immediate and remunerative employment in the drafting-room, or for engagements in the wide field of electrical and mechanical engineering, where, it is believed, their training will lead to rapid advancement.

(*c*) For entrance to advanced standing into an institution of technology, should a higher technical education be desired.

For the attainment of these objects there is one carefully planned general course of study, no effort being made to specialize until the fourth year, by which time a student will have acquired a considerable degree of practical skill and intimate knowledge in some one of the professions based on mechanical art and applied science that he may have elected to follow. Thus, for example, the student who may, toward the end of the course, elect to follow electrical engineering as

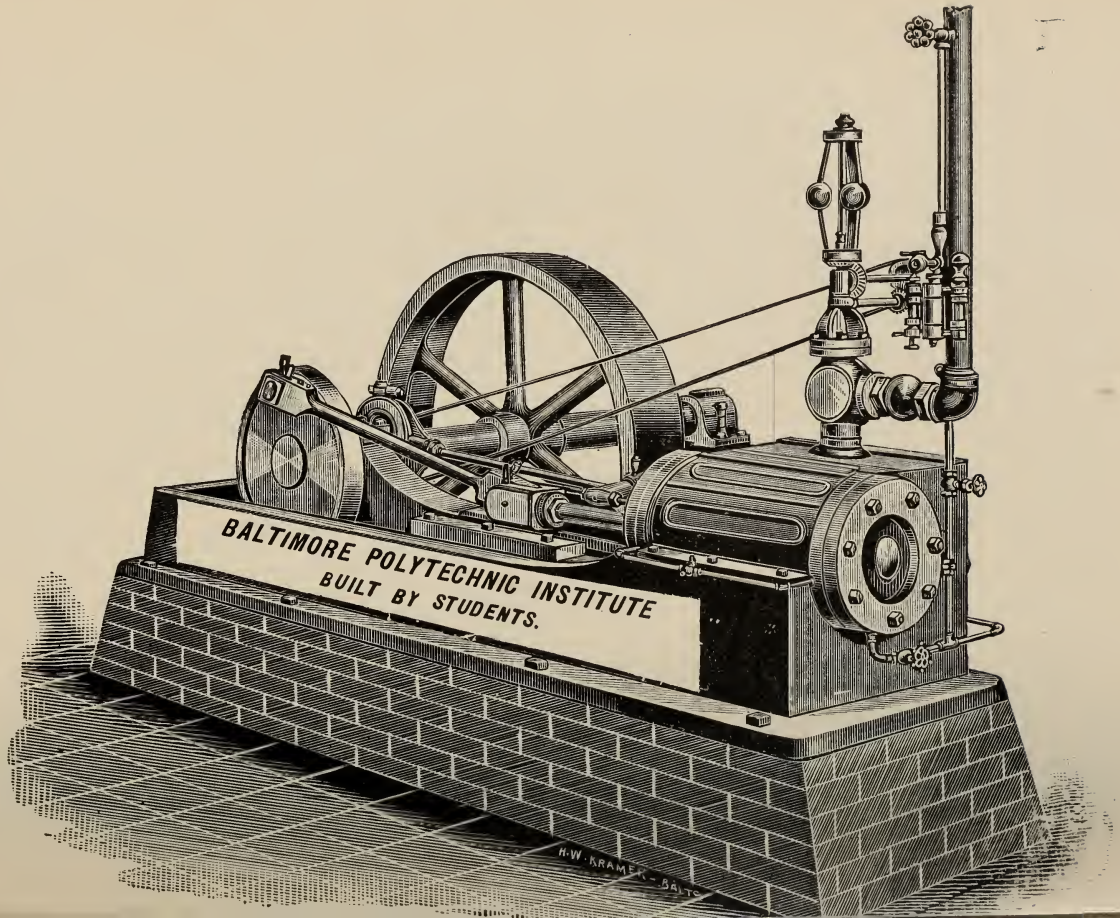
a profession, will be afforded special opportunities for laboratory practice in the manipulation of currents, methods of testing, etc. The student who elects to follow mechanical or steam engineering as a life work, studies the elements of the theory of construction and operation of machines, special attention being given to the theory of the steam engine. In the drawing-room he is given elementary work in engine and machine design, and in the shops he does some actual work in engine and machine building.

No attempt is made to teach trades, but the equipment is of such a nature that the instruction given in the shops is designed to be correlative to the work of the class-room, and results are aimed at that will insure success in mechanical pursuits subsequent to graduation. It is believed that instruction in correct methods of using tools, and practical illustrations of how, and for what purpose, things are done, are of more value than mere excellence in hand skill.

Instruction in the English Department is given during the first, second, and third years, and embraces Composition, Rhetoric, Literature, History, and Civics. Special effort is made to inculcate sound principles in the choice of words and in phraseology, and frequent written exercises in the various kinds of composition are required of the student. The first year work in History is followed in the second year by a course in Civics, which is designed to ground the student in the fundamental principles of government and to emphasize their application to American citizenship.

The instruction in German during the second and third years, and in French during the fourth year, is designed to give a reading, rather than a speaking knowledge of these languages, in order to meet entrance requirements of institutes of technology.

In Mathematics, care is taken at the beginning of the first year to discover and correct any defects in fundamental training, after which the course of instruction proceeds in Algebra, Geometry, Trigonometry, and Analytical and Descriptive Geometry. During the fourth year the instruction


BALTIMORE POLYTECHNIC INSTITUTE
BUILT BY STUDENTS.

given in the Engineering Department in Dynamics and Thermodynamics involves in its very elements the use of equations and mathematical principles which can be understood only by resort to the Calculus. For this reason instruction in the Differential and Integral Calculus is indispensable. The course is sufficiently broad to fit students for more advanced work, and includes the fundamentals of differentiation and integration, the development of the theorems of Taylor and Maclaurin, and applications of the subject to questions of maxima and minima, areas, volumes, and moments of inertia. Without such instruction, a student at graduation will be unable to read understandingly a treatise on any of the mechanical sciences.

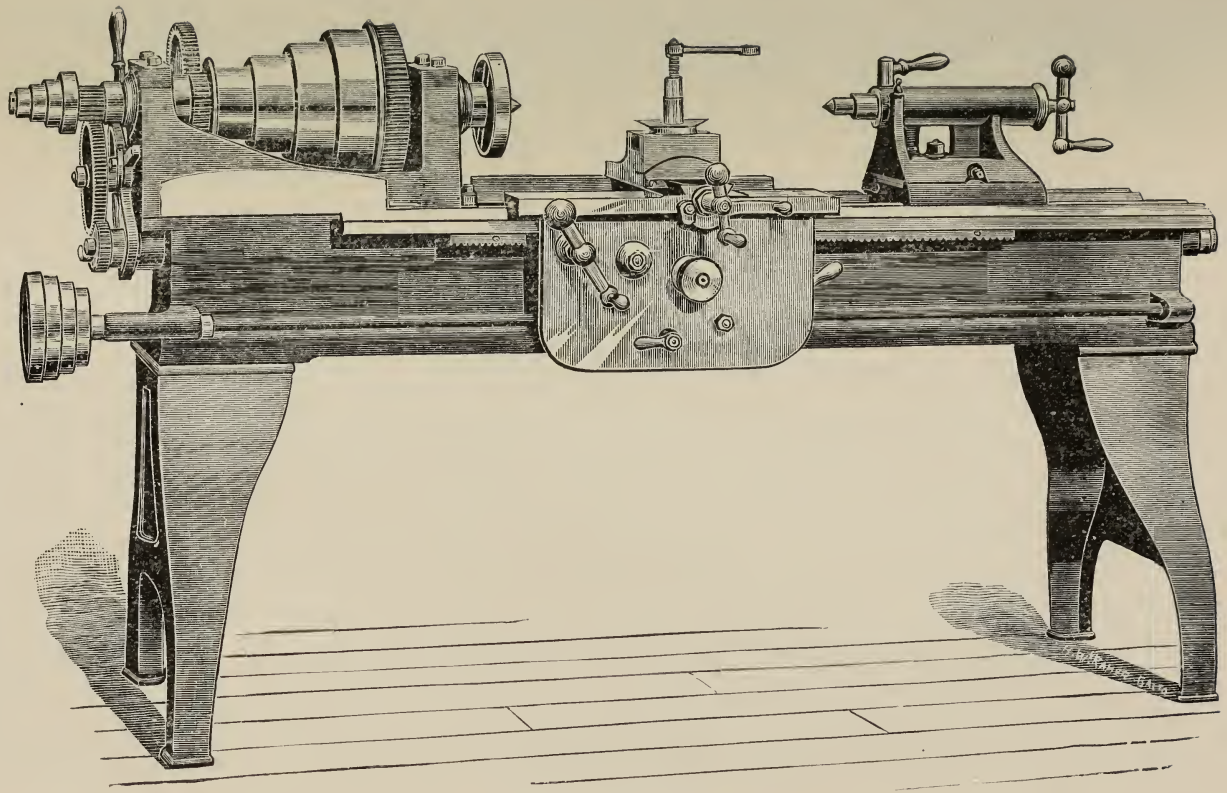
In Physics, the work of the first and second years embraces the properties of matter and elementary mechanics, the instruction being accompanied with lectures illustrated by experiments, and with practical work in the laboratory. The instruction of third and fourth year students in this subject is confined to Heat and Electricity. The dynamic theory of heat, the conversion of heat into mechanical work, and the thermodynamics of the steam engine are the particular features of the fourth year in the study of Heat.

In Electricity, the work of the fourth year consists of practical applications of the theoretical study of the second and third years, and of commercial electricity. Electric lighting, both arc and incandescent, is discussed from constructive and economic standpoints, especially high and low voltage distribution. The dynamo and motor are treated in detail—operating, designing, and winding being carefully considered. The experimental equipment for this work consists of a twenty-five kilowatt generator, built by the students; a one-half horse power alternating current motor coupled to a twenty-five volt multipolar generator; and several smaller machines of various types. These appliances, with the electric light equipment of the Institute, present opportunities for personal observation and operation of electrical machinery and the various defects and faults to be overcome. Alternating cur-

rents are treated both mathematically and experimentally, and converters, motors, impedance coils, and measuring instruments are used by students for verifying laws and descriptions given in lectures. The main and laboratory switchboards and the generating plant afforded opportunities for power-station practice, and the electric railway is treated in a practical manner. The newest and best methods of telegraph and telephone construction are presented, the telephones of the Institute being installed on the central-energy plan. Special features of the course are the various tests for insulation resistance of conductors, the tests for grounds, faults, and short circuits on lines, and a treatment of the defects in the dynamo and motor, and remedies therefor.

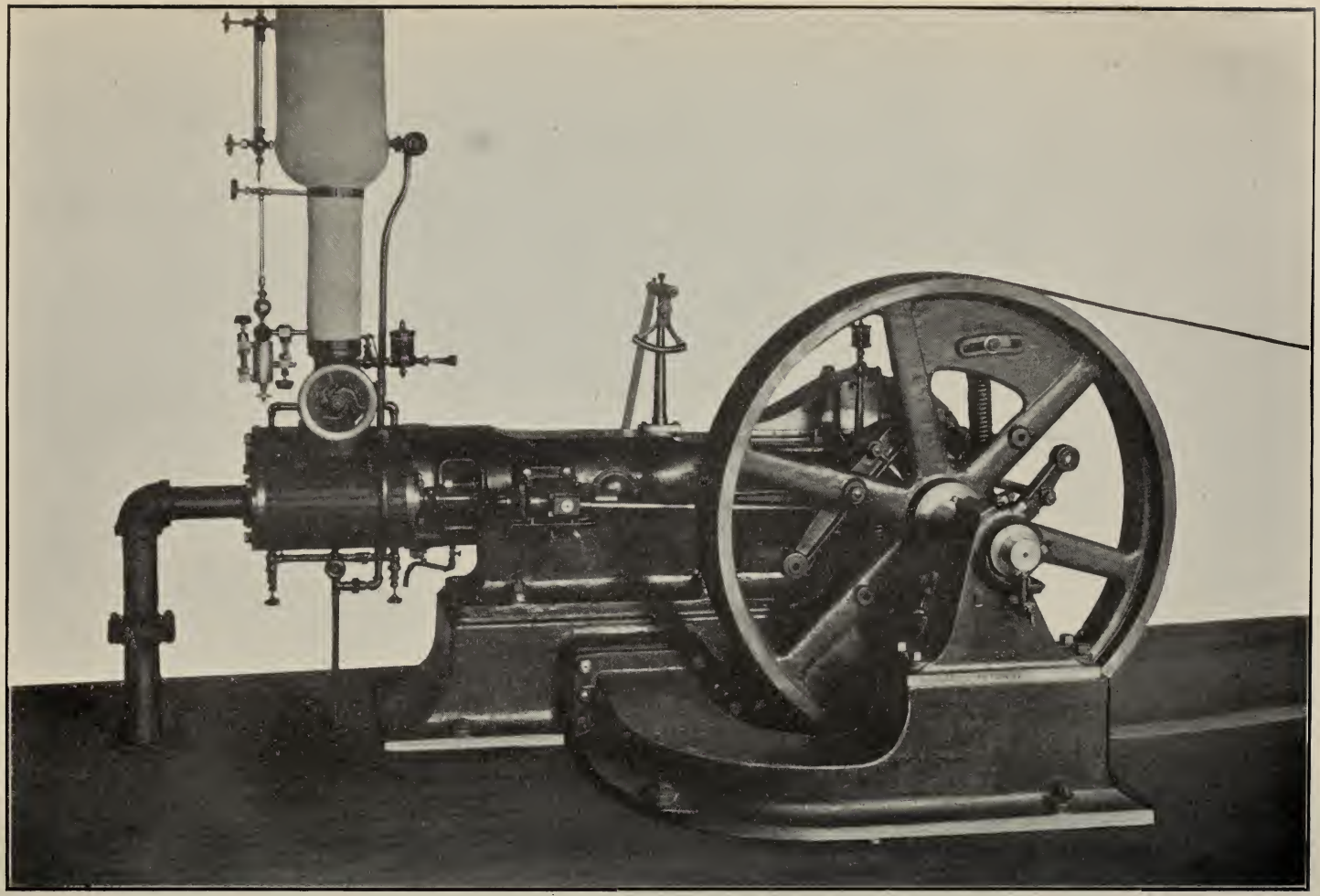
For the study of Chemistry there are chemicals and apparatus in the laboratory to give to the third year students instruction concerning the nature and reactions of the chemical elements and their compounds, and to students of the fourth year a brief course in qualitative and quantitive analysis, the compounds formed in the various reactions and their chemical equations being particularly emphasized.

In the Department of Engineering the instruction given the fourth year students in theoretical and applied mechanics, which extends well into the Sophomore year of an institute of technology, embraces the laws of equilibrium and motion; centre of gravity; friction; principles of work; moments of inertia; mechanics of materials; and an elementary study of the stresses and deformations produced in standard specimens of metals when subjected to tension, compression, and shearing. The work of the third and fourth year students in steam engineering consists of the study of thermodynamics of the steam engine in as comprehensive a manner as the facilities of the Institute and the maturity of the students permit. Numerous calculations are made involving engine and boiler efficiencies and proportions, and the study of the indicator is supplemented with practice in taking diagrams, from which the consumption and distribution of the steam, and the power of the engine are determined. The advantages and disadvan-



BUILT BY STUDENTS.

tages of the different kinds of steam boilers are studied, particular attention being given to such attachments as separators, feedwater heaters, and mechanical stokers. The plan for this work consists of an inverted triple expansion engine of 100 I. H. P., an inverted compound engine of 60 I. H. P., a high speed automatic cut-off engine (Harrisburg standard) of 46 I. H. P., a horizontal power engine of 25 I. H. P., a Campbell & Zell sectional boiler (rated at 100 horse-power), and a Roberts safety water tube boiler, capable of generating steam for the production of 120 I. H. P. when used in connection with the triple expansion engine. The engines mentioned above were built by the students, the first two after designs of the Bureau of Steam Engineering of the Navy Department. Grouped in the mechanical laboratory are all the engines, the 25 K. W. generator, the switchboard controlling the lighting installation of the Institute, and a Riehle testing machine of 50,000 pounds capacity. The compound and triple expansion engines may be worked singly or together in connection with a friction dynamometer specially designed at the Institute, an internal circulation of water in the brake wheel enabling the engines to run coutinuously in making power tests. The Roberts boiler is installed in a room immediately connected with the laboratory, and furnishes steam at 150 pounds pressure per square inch for the stage expansion engines, and at 95 pounds and 40 pounds to the high speed and power engines, respectively, Foster regulators reducing the pressure as desired. Horizontal and vertical separators are placed in the steam pipes to insure the delivery of dry steam to the engines, and connections are made for calorimeter tests. The surface condenser used in connection with the stage expansion engines may also be connected with the exhaust of the high-speed engine when desired. The water from condensation is delivered to a filter of approved design by a Knowles independent air pump, and thence direct to the boiler, either by a Dean pump or Penberthy injector. For purposes of economy tests of the engines and boiler, the feed water is made to pass through weighing tanks of galvanized iron.



HIGH SPEED AUTOMATIC CUT-OFF ENGINE (HARRISBURG STANDARD).

Built by Classes of 1901 and 1902.

In the mechanical drawing-room are seventy-five tables of approved design, and an equipment of instruments and models well adapted to the requirements of an advanced course in the subject. Fourth-year students are required to make a free hand sectional sketch of some machine, from which a finished drawing, tracing, and blue print are made, and their work in design tends to make them draftsmen in the truest sense—not mere copyists.

The material equipment in the machine, pattern, forge, sheet metal and carpentry shops is equal, and in some respects superior, to that of any similar institution in the country.

It is gratifying to announce that, in the general scheme for municipal improvements, the Board of School Commissioners has asked for an appropriation of $250,000 to be expended in the erection or a new building for the Institute, on a lot to be acquired.

THE COURSE OF INSTRUCTION IN DETAIL.

NOTE.—Pupils who complete the four year course as here outlined, and are recommended, will be admitted without examination to full Sophomore standing in the course leading to the degree of Mechanical Engineer or Electrical Engineer, at Sibley College, Cornell University.

Five members of the class of 1902, availing themselves of this privilege, entered Cornell last September. The following letter bears testimony as to the character of the preparation they received:

SIBLEY COLLEGE, FACULTY OF MECHANICAL ENGINEERING.
CORNELL UNIVERSITY. W. F. DURAND, *Secretary*.
R. H. THURSTON *Director*. ITHACA, N. Y., *September 29, 1902*.

WM. R. KING, U. S. N.,
Principal, Baltimore Polytechnic Institute, Baltimore, Md.

DEAR SIR:

The five boys referred to in yours of the 19th inst. arrived on time and were duly entered. They passed up the full Freshman year and received a little credit on some of the Sophomore work. They are in excellent shape to complete our course in three years' time, which, I have no doubt, they will do with credit to themselves and to their training in your school.

Sincerely yours,
W. F. DURAND.

DEPARTMENT OF ENGINEERING AND APPLIED MECHANICS.

FIRST YEAR COURSE—D CLASS.

Lectures and Practical Exercises.

(*a*) *Carpentry*.—16 weeks, 6 periods a week.

(*b*) *Sheet Metal*.—16 weeks, 6 periods a week.
Soldering; sheet metals; Venetian iron and repousse work.

(*c*) *Mechanical Drawing*.—32 weeks, 4 periods a week.
Use of instruments; lettering; elementary lessons.

SECOND YEAR COURSE—C CLASS.

Lectures and Practical Exercises.

(*a*) *Review of Carpentry.*—4 weeks, 6 periods a week.

(*b*) *Introductory Vise Work.*—8 weeks, 6 periods a week.

(*c*) *Forge.*—8 weeks, 6 periods a week.

Light forging and welding.

(*d*) *Pattern.*—12 weeks, 6 periods a week.

(*e*) *Mechanical Drawing.*—32 weeks, 5 periods a week.

Hatching; tinting; neatness and accuracy; scale drawing.

THIRD YEAR COURSE—B CLASS.

Steam and the Steam Engine.—32 weeks, 4 periods a week.

Early history and progress of steam engineering; combustion of fuel and steam generation; efficiency; economy of fuel; the indicator; horse power; the slide valve.

Mechanical Drawing.—32 weeks, 4 periods a week.

Detail drawings of machines from free-hand sketches; the working drawing, tracing and blue print. Descriptive Geometry (see course in Mathematics).

Practice.—(*a*) Pattern Shop; 16 weeks, 6 periods a week.

Exercises in making patterns for wrenches, pulleys, eccentrics, pillow-blocks, gears, globe valves, pipe joints, and core boxes where necessary.

Lectures on construction and finish of patterns; green sand molding, open sand molding, loam molding, mixing of iron and of brass, and on the operation of the cupola.

(*b*) Machine Shop, Forge Shop, and Laboratory; 16 weeks, 6 periods a week.

Work on the lathe, planer, milling machine, drill-press, and vise. Forging and tempering machine cutting tools; casehardening; chasing. Valve setting; operating engines and taking indicator diagrams.

FOURTH YEAR COURSE—A CLASS.

Lectures and Recitations.—32 weeks, 3 periods a week.

Steam and the Steam Engine.—Thermodynamic applications; the laws of Charles and Boyle; kinetic theory of heat; absolute zero of temperature; the expansion of gases, with particular refence to different conditions of steam expansion; details of steam engine; link motion; clearance and compression; indicator diagrams—theoretical and actual; steam consumption per unit of power; mean effective pressure; stage expansion engines; condensers; boilers; engineering materials.

Mechanics.—32 weeks, 3 periods a week.

First Principles.—Matter; mass; inertia; velocity; acceleration; force; absolute measure of force; gravity; gravitation units of measure; comparison of gravitation and absolute measure of force.

Kinematics.—Motion in a straight line with a constant acceleration; falling bodies; resolution and composition of velocities; the conversion of motion; harmonic motion; velocity ratios.

Dynamics.—(*a*) Statics.—The paralellogram, triangle, and polygon of forces; composition and resolution of forces; conditions of equilibrium; transmissibility of force; parallel forces; moments of forces and of couples; conditions of equilibrium of a body under the action of three forces in one plane; centre of gravity; friction; virtual velocities; the mechanical powers. (*b*) Kinetics.—The laws of motion; centripetal and centrifugal forces; kinetic energy, or vis viva, of a moving body; work.

Mechanics of Materials.—Stress; strain; elastic limit; ultimate strength; bending and resisting moments; moment of inertia; radius of gyration; simple and cantilever beams; struts; deflection; torsion; resilience; bending-moment and shear diagrams.

Design and Mechanical Drawing.—32 weeks, 4 periods a week.

Design.—Some part of an engine or of a tool, such as cylinder, connecting rod, valve, screw-jack; Zeuner diagram.

Mechanical Drawing.—The drafting accompanying the work in design; free-hand sketches, from which are made the finished drawing, the tracing, and the blue print.

Practice.—32 weeks, 4 periods a week.

Actual running and indicating of steam engines; testing for tension, compression, and flexure with a Riehle machine; machine work involving accuracy and finish; economy tests of engines and boilers; calorimeter tests for quality of steam.

DEPARTMENT OF MATHEMATICS.

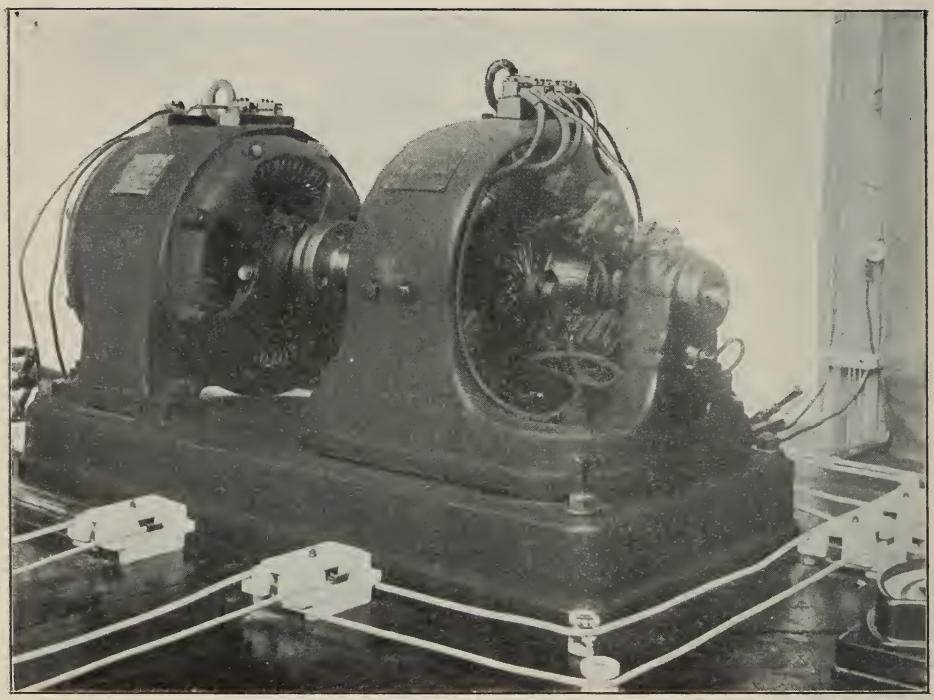
FIRST YEAR COURSE.—D CLASS.

Explanation and Demonstration.—32 weeks, 2 periods a week.

The most difficult and important features of the course are explained and demonstrated by the instructors.

Algebra.—32 weeks, 4 periods a week.

Fundamental operations; integral equations; factors and multiples; fractions; simultaneous linear equations; inequalities; indeterminate linear equations; involution; evolution; surds; imaginary and complex numbers; doctrine of exponents; the reduction and



WESTINGHOUSE MOTOR-GENERATOR.
Used in Laboratory.

solution of quadratic equations; ratio and proportion; arithmetical, geometrical, and harmonical progressions; permutations; combinations; binomial theorem.

Geometry.—32 weeks, 3 periods a week.

Geometry of the straight line and circle; proportion; properties of similar figures; original exercises.

SECOND YEAR COURSE—C CLASS.

Geometry.—16 weeks, 4 periods a week, and 16 weeks, 3 periods a week.

Areas of polygons; regular polygons; circles; lines and planes in space; polyhedrons; cylinder; cone; sphere; original exercises.

Advanced Algebra.—16 weeks, 2 periods a week.

Comprehensive review of the work of the preceding year from surds; partial fractions; binomial theorem; logarithmic usage; exponential and logarithmic series.

Plane Trigonometry.—16 weeks, 3 periods a week

Functions of the acute angle; the right triangle; use of tables; goniometry.

THIRD YEAR COURSE—B CLASS.

Plane Trigonometry.—10 weeks, 3 periods a week.

The oblique triangle; miscellaneous examples.

Spherical Trigonometry.—12 weeks, 3 periods a week.

The right spherical triangle; the oblique triangle; applications of spherical trigonometry.

Surveying.—10 weeks, 3 periods a week.

Instruments and their uses; land surveying.

Analytic Geometry.—32 weeks, 4 periods a week.

The straight line; circle; parabola; ellipse; hyperbola; transformation of co-ordinates; construction of loci; higher plane curves.

Descriptive Geometry—Time taken from Mechanical Drawing, as the subject is taught in conjunction with that subject.

Projections; problems in straight line and plane; projections and sections of solids; curved surfaces and tangent planes; development and projection of screw threads; intersection of surfaces.

FOURTH YEAR COURSE—A CLASS.

Differential and Integral Calculus.—32 weeks, 5 periods a week.

Differentiation of algebraic and of transcendental functions; successive differentiation; expansion of functions, including the development of Maclaurin's and of Taylor's theorems; evaluation of indeterminate forms; mode of variation of functions of one variable, including geometric problems in maxima and minima; differ-

entiation of functions of more than one variable; tangents and normals; derivatives of arcs, areas, volumes, and surfaces of revolution; circle of curvature; radius of curvature; fundamental rules and methods of integration; geometrical applications of the calculus to lengths of curves, to areas, to volumes of solids of revolution; integration of trigonometric functions; successive integration; applications to mechanics.

DEPARTMENT OF PHYSICS AND CHEMISTRY.

FIRST YEAR COURSE—D CLASS.

General Physics.—32 weeks, 2 periods a week.

Properties of matter; C. G. S. units; falling bodies; work and power; elementary mechanics; specific gravity; elements of hydromechanics; pressure and expansion of air; lectures illustrated by experiments; practical work in laboratory.

Physical Geography.—32 weeks, 2 periods a week.

The subject is taught by lectures, demonstrations, and recitations, the relation between physiographic conditions and commercial and agricultural products being emphasized.

SECOND YEAR COURSE—C CLASS.

Heat.—32 weeks, 2 periods a week.

Thermometers; calorimetry; coefficients of expansion; boiling points; distillation; latent heat; laws of thermodynamics; mechanical equivalent of heat.

Electricity.—32 weeks, 2 periods a week.

Magnetism; currents; induction; static electricity; lectures and experiments; practical work in laboratory.

THIRD YEAR COURSE—B CLASS.

Electricity.—32 weeks; 3 periods a week.

Deduction of formulæ; use of galvanometers; magnet testing; laws of induction; simple alternating currents; relation of electricity to work and power; practical work in laboratory.

Chemistry.—32 weeks, 2 periods a week.

Recitations in general chemistry; experiments illustrating text.

FOURTH YEAR COURSE—A CLASS.

Electricity—32 weeks, 4 periods a week.

Lectures and recitations in applied electricity, including electrochemical action; principles of the dynamo, motor, and transformer; railways; line and machine testing; telegraph and telephone; electric lighting; practical work in laboratory.

Chemistry.—32 weeks, 4 periods a week.

Theory of analysis; qualitative analysis of solutions containing one base and one acid; qualitative analysis of solution containing several salts; qualitative analysis of powders; quantitative analysis of silver, ammonia, and iron solutions by volumetric method; quantitative analysis of solutions for barium and phosphoric acid by gravimetric method; simple determination of carbon, sulphur, manganese, and silicon in iron and steel.

DEPARTMENT OF ENGLISH, INCLUDING HISTORY AND LANGUAGE.

FIRST YEAR COURSE—D CLASS.

Composition and Rhetoric.—32 weeks, 2 periods a week.

Study of text and frequent written exercises in Paragraphing and Sentence Structure, based upon Narration and Description; Letter Writing.

Literature.—32 weeks, 2 periods a week.

(*a*) Leading facts in the lives of representative American writers.

(*b*) Reading and study in class of the following selections: Legend of Sleepy Hollow, Forest Hymn, Evangeline, The Gold Bug, Snow-bound, Vision of Sir Launfal, Selections from Holmes.

History.—32 weeks, 3 periods a week.

The course includes Greek and Roman history, and the subjects are taught both chronologically and topically.

SECOND YEAR COURSE—C CLASS.

Composition and Rhetoric.—32 weeks, 2 periods a week.

Study of text and frequent written exercises upon the Sentence, the Paragraph, and the Whole Composition.

Literature.—32 weeks, 2 periods a week.

(*a*) Leading facts in the lives of representative English writers since Pope's time.

(*b*) Study in class of the following texts: The Vicar of Wakefield, Ivanhoe, Silas Marner, The Princess, The Lady of the Lake, The Ancient Mariner.

German.—32 weeks, 3 periods a week.

Study of the grammar, and reading.

Civics.—32 weeks, 2 periods a week.

The principles of government and their applications to American citizenship.

THIRD YEAR COURSE—B CLASS.

Literature.—32 weeks, 2 periods a week.

Study of the works selected for 1903 by the Committee on Uniform Entrance Requirements. The works prescribed are Macbeth, Macaulay's Essays on Milton and Addison, Burke's Speech on Conciliation with America, and Milton's Comus, Lycidas, Il Penseroso, and L'Allegro. Frequent written exercises.

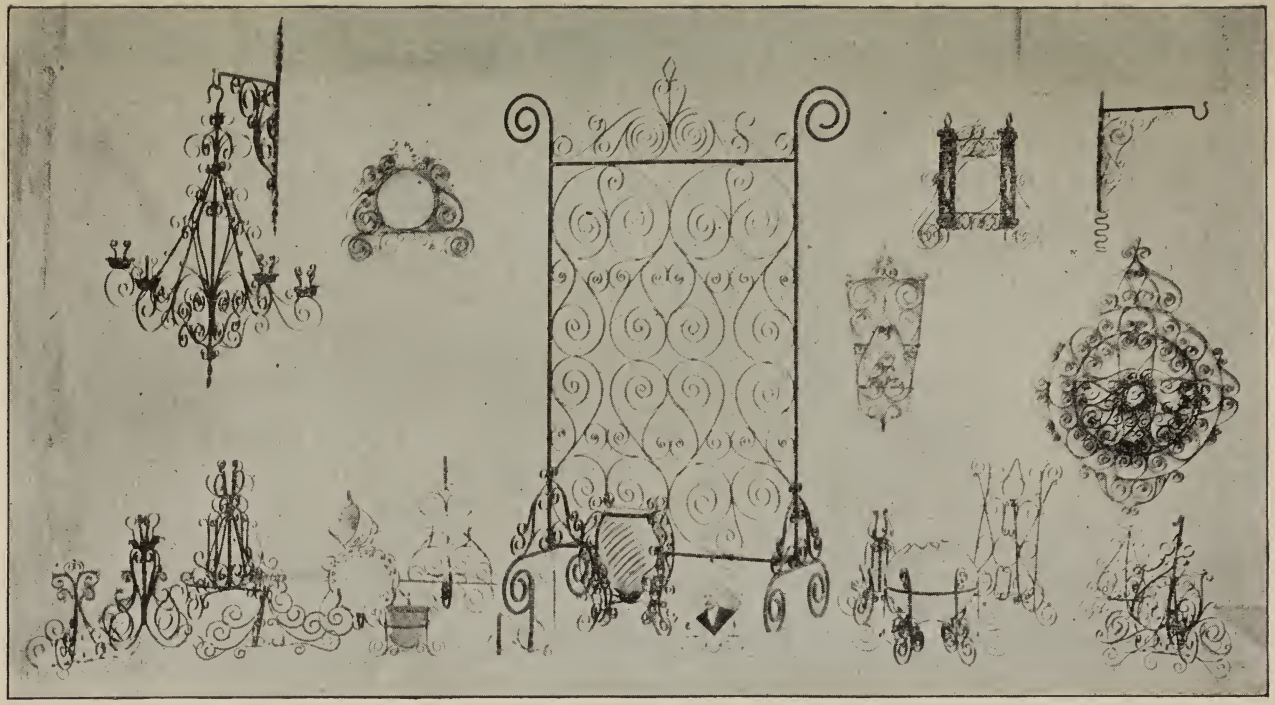
German.—32 weeks, 2 periods a week.

Composition, and reading easy prose on scientific topics.

FOURTH YEAR COURSE—A CLASS.

French.—32 weeks, 3 periods a week.

Study of the grammar, and reading simple science.



VENETIAN IRON WORK.

REQUIREMENTS FOR ADMISSION.

Pupils bearing properly attested certificates of having passed the prescribed Grammar School Course of the Public School System of Baltimore are entitled to enrollment.

Other applicants residing in the city will be admitted after passing an examination covering the requirements of the eighth grammar school grade. Eighth grade grammar school pupils who failed of promotion are not eligible for admission under this requirement. Specimen entrance examination papers covering the requirements of the eighth grade will be found on pages 59 and 60.

Non-resident applicants, in addition to passing the entrance examination, are required to pay an annual fee of $72.00, charged for tuition and for the use of books.

After having successfully passed the entrance examination, a non-resident applicant must register as such at the office of the Secretary of the Board of School Commissioners, where he will be furnished with a bill for the first quarterly installment of the fee; and a presentation at the Institute of a coupon from the bill, signed by the City Comptroller, will be accepted as evidence of payment, and entitle the applicant to enrollment.

MERIT ROLLS.

Merit rolls, showing the proficiency of students in each branch of study, are made out annually for the different classes.

Each subject is assigned a coefficient indicative of its relative weight; and the final mark of a student in a subject (on a scale of 100) is multiplied by its coefficient. The sum of the products is the final mark of the student for the year. This mark is a certain percentage of the sum of the coefficients, and such percentage is the student's average for the year.

TIN WORK.

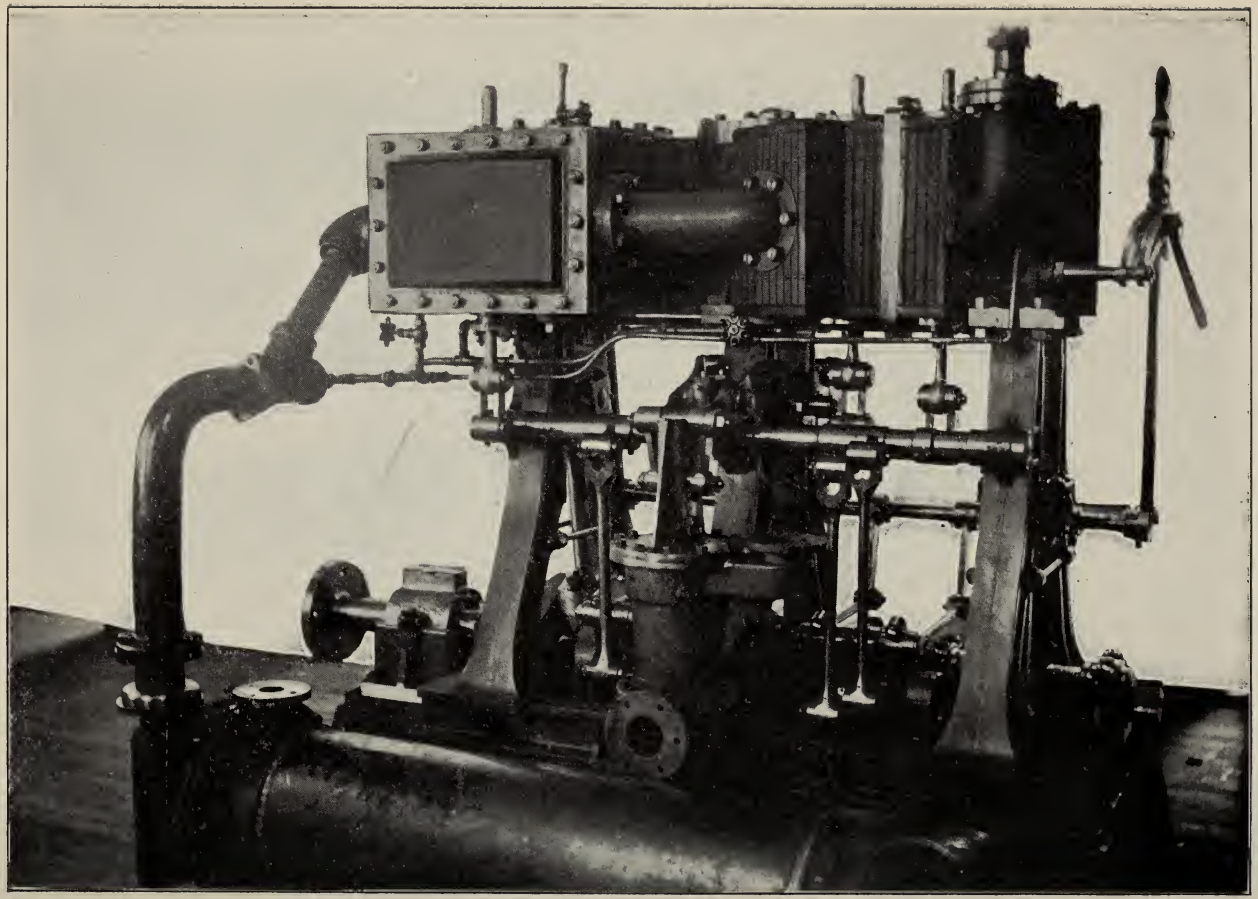
FINAL MERIT ROLL AND FOURTH YEAR RECORD OF GRADUATING CLASS OF 1903.

Order of Merit.	Names.	Date of Admission.	Mechanics.	Mechanics of Materials.	Steam Engineering.	Mech. Drawing and Design.	Diff. and Integral Calculus.	Chemistry.	Applied Electricity.	French.	Practice.	Conduct.	Aggregate for 4th Year.	Aggregate for 3d Year.	Aggregate for 2d Year.	Aggregate for 1st Year.	Aggregate for 4th, 3d, 2d, & 1st Years.	Graduating Average.
	Maxima		7	10	10	8	10	10	10	5	5	5	80	60	40	20	200	100
9	J. B. Cautley.....	1897	No. 8 5.39	No. 11 7.40	No. 6 8.20	No. 12 6.24	No. 8 7.90	No. 4 9.00	No. 4 8.30	No. 3 4.15	No. 9 4.30	No. 4 4.05	64.93	49.30	32.51	15.41	162.15	81.08
8	R. Dall, Jr.....	1897	No. 10 5.18	No. 8 7.90	No. 8 7.80	No. 5 7.28	No. 9 7.70	No. 3 9.10	No. 3 8.40	No. 9 3.80	No. 4 4.60	No. 1 5.00	66.76	48.44	31.38	15.68	162.26	81.13
‡	A. C. Davis.....	1893	No. 3 6.23	No. 3 9.00	No.	No. 6 7.28	No. 3 8.70	No. 6 8.70	No.	No. 6 4.05	No. 12 3.80	No. 3 4.75	52.51				x 52.51	
§ 1	W. L. De Baufre.....	1898	No. 1 6 79	No. 1 9.50	No. 1 9.70	No. 1 7.68	No. 1 9.50	No. 1 9.50	No. 1 9 70	No. 1 4.65	No. 1 4.90	No. 1 5.00	76.92	57.36	37.45	18.73	190.46	95.23
7	J. K. Flickenschildt	1898	No. 7 5.81	No. 10 7.40	No. 9 7.60	No. 9 7.12	No. 11 7.40	No. 11 8.10	No. 11 7.30	No. 11 3.40	No. 10 4.20	No. 1 5.00	63.33	50.34	33.98		* 147.65	82.03
5	W. M. Gieske.....	1897	No. 9 5.39	No. 7 8.00	No. 7 8.10	No. 2 7.52	No. 10 7.50	No. 10 8.30	No. 9 7.90	No. 10 3.75	No. 3 4.70	No. 3 4.75	65.91	49.84	33.82	16.55	166.12	83.06

FINAL MERIT ROLL AND FOURTH YEAR RECORD OF GRADUATING CLASS OF 1903—*Continued.*

Order of Merit.	Names.	Date of Admission.	Mechanics.	Mechanics of Materials.	Steam Engineering.	Mech. Drawing and Design.	Diff. and Integral Calculus.	Chemistry.	Applied Electricity.	French.	Practice.	Conduct.	Aggregate for 4th Year.	Aggregate for 3d Year.	Aggregate for 2d Year.	Aggregate for 1st Year.	Aggregate for 4th, 3d, 2d, & 1st Years.	Graduating Average.
	Maxima		7	10	10	8	10	10	10	5	5	5	80	60	40	20	200	100
2	D. S. Hays	1897	No. 5 6.09	No. 5 8.40	No. 3 8.90	No. 4 7.36	No. 5 8.50	No. 5 9.00	No. 2 9.20	No. 2 4.30	No. 2 4.70	No. 1 5.00	71.45	54 22	34.59	16.56	176 82	88.41
3	J. S. Hess	1897	No. 4 6.09	No. 4 8.70	No. 4 8.60	No. 7 7.20	No. 2 8.90	No. 2 9.30	No. 8 8.00	No. 4 4.10	No. 5 4.55	No. 5 3.55	68.99	53.72	35.09	16.12	173.92	86.96
6	I. S. Jones	1901	No. 6 5.81	No. 9 7.90	No. 5 8.20	No. 8 7.20	No. 7 8.00	No. 7 8.70	No. 7 8.10	No. 5 4.10	No. 8 4.35	No. 2 4.95	67.31	48.36			‖ 115.67	82.62
10	L. M. Langrall	1900	No. 11 4.90	No. 6 8.10	No. 10 7.40	No. 3 7.44	No. 6 8.10	No. 12 8.00	No. 10 7.60	No. 7 3.95	No. 11 3.85	No. 2 4.95	64.29	48.72	32.00		* 145.01	80.56
4	H. Q. Layman	1896	No. 2 6.30	No. 2 9.10	No. 2 9.00	No. 11 6.80	No. 4 8.60	No. 9 8.60	No. 5 8.20	No. 8 3.90	No. 6 4.45	No. 2 4.95	69.90	51.52	33.46	17.21	* 172.09	86.05
†	C. A. Pettit	1899	No.	No.	No. 11 7.30	No. 10 6.88	No.	No. 8 8.70	No. 5 8.20	No.	No. 7 4.40	No. 6 2.35	37.83	47.94	31.29	15.19	132.25	

x Aggregate for 1 year. ‖ Aggregate for 2 years. * Aggregate for 3 years.
‡ Graduated in 1899, returned as special student for the year 1902-3. Record incomplete for 1st, 2d, and 3d years.
† Specialized in Manual Training.
§ Passed up Physical Geography of 1st Year Course and Civics of 2d Year Course.



TRIPLE EXPANSION ENGINE.

Built by students after design of the Bureau of Steam Engineering, Navy Department.

THE ENGINEERING PROFESSION.

ADDRESS DELIVERED BY W. M. MCFARLAND, VICE-PRESIDENT OF THE WESTINGHOUSE ELECTRIC COMPANY, BEFORE THE GRADUATING CLASS OF THE POLYTECHNIC INSTITUTE, BALTIMORE, AND REPORTED IN FULL FOR THE JOURNAL.

Mr. Chairman, Members of the Graduating Class, Ladies and Gentlemen:

I count it an honor and a pleasure to have been invited to address you this evening. It is an honor, because, in talking to young people who have so many opportunities before them, one has a chance to say something which may be of real service, based on his longer experience and wider horizon. It is a pleasure, because it is always delightful to take part in an occasion like this, which represents the successful ending of faithful work and the beginning of a new field of labor. For some it is the beginning of active life, while others will continue their studies in other institutions, but for both it is the definite close of one stage of their career and the beginning of a new one. That would be a dull nature indeed, without enthusiasm and without imagination, which could fail to share in the elation and happiness of this evening.

My theme is the glory of the engineering profession, in the ranks of which these young men have all enrolled themselves. As yet they are "privates" in this great army, but I can assure them that what Napoleon said of the men in his army, namely, that every soldier carried a marshal's baton in his knapsack, is eminently true of those who enter the ranks of the great army of engineers. Every one may aspire to be a leader in the profession.

It would be only natural on an occasion like this, when an older engineer is speaking to younger ones, that he should glory in the profession to which they all belong, but I think if you will stop to consider for a moment what the engineer has done, you will agree with me that I am hardly claiming too much when I say it is to-day the greatest of all the professions. I do not forget that there are others of great importance, and that we may be told at once that the doctor saves life, but if the doctor does save life, the engineer makes life worth living.

Let us think for a moment to how great an extent we are indebted to the engineer for the comforts and luxuries as well as the necessities of modern life, and we shall see how important a part he plays. As soon as we leave the country, with its individualism, and come to the great city, where collectivism is the rule, we find the hand of the engineer in everything. He constructs our water-works, including the reservoirs, the pumping station and the distributing plant; he gives us our steam and electric railroads, which enable us to accomplish in a day what took a month before his advent; he has given us the electric light, the telegraph, the telephone; he provides the well-paved streets of the cities, the bridges which span our great rivers and the mighty tunnels which bore through the heart of the mountains. It is to the engineer also that we owe the means of obtaining cheap food, with cold storage, the grain elevators and the other means of hauling food products expeditiously and cheaply. Indeed, it would take up too much time and would weary you if the attempt were made to exhaust the list of the doings of the engineer.

Is it not natural, therefore, that the young man who has chosen this for his profession should be filled with enthusiasm when he realizes that it is of such great service to the world as to be absolutely vital, that its gaze is ever toward the future, and its motto "Progress?" I cannot imagine anything more discouraging than to feel that one's preparation for active life has landed him in a calling or business which is on the decline. There may still be opportunities for personal success, but the need for the work is passing away, and he feels that he is simply helping to delay the inevitable disappearance.

I remember a story which was told me, when I was a beginner like these young graduates, by a dear old friend, himself an engineer of eminence, about the introduction of the first steam fire engine in the city of Philadelphia. As the older people here know, fifty years ago the fire departments in nearly all our large cities were composed of volunteers. In Philadelphia one of the fire companies consisted of young men from the leading families, who had a hand engine, built by the best maker, and believed to be the best that could be made. Somewhere along in the 50's, when the steam fire engine had been developed, one was offered to the city of Philadelphia, and arrangements were made for a competitive trial between this and the noted hand engine. The scene of the test was at the Dr. Jayne Building, which was then the highest in the city. The young men arrived with their beautiful machine, full of enthusiasm and believing that the smoky little steamer would be thoroughly discomfited. Everything being in readiness, they worked with a will, and barely succeeded in throwing a stream just to the top of the flagstaff, the highest point of the building. The man in charge of the steamer was a little Irishman, who had everything in good shape, and who, when he saw the

work of the hand engine, turned to his fireman, who had been blowing off steam at the safety valve, and said: "Screw down the safety, Jimmy." The pumps were started and a stream was thrown thirty feet above the top of the flagstaff and maintained there. The heart-broken young men hauled their beautiful machine home to become simply a relic. The day of simple brawn and muscle had passed; the day of steam had come.

I have spoken of the great opportunities which the engineering profession offers to all its members, especially, of course, to those of ability and enterprise. These opportunities are not only to become famous, wealthy, and identified with great undertakings, but often to render inestimable benefit to mankind. A notable instance of this last feature is the case of the great man who is at the head of the company with which I am connected, Mr. George Westinghouse. If he had done nothing but invent the airbrake he would still be one of the greatest benefactors of humanity, because the saving of life consequent upon that invention is almost incalculable. Further than that, it has made modern high-speed railroading possible. It would be simply out of the question to attempt to run our fast passenger trains, or the huge freight trains which are now so common, without the perfect brake which he gave the world.

Another name which is probably not so well known to the general public, but which among engineers is held in the greatest veneration and respect, is that of John Fritz, who built up the great Bethlehem Steel Works, and who, as the inventor of the three-high roll train, rendered such conspicuous service to the steel industry. The eightieth birthday of this great engineer and lovable old gentleman was celebrated last year by the founding of the John Fritz Medal, supported by a fund contributed by engineers all over our country, and also by a banquet in New York given by representatives of all branches of the profession, at which time congratulatory letters and telegrams were sent to him from all parts of the world.

The famous man who addressed you last year, and whom I count it a great honor to have served as an assistant for many years, Admiral Melville, is another illustration, by his work in the building of the new navy, of the opportunities of the engineer. It is particularly appropriate also that in connection with him I should mention two other engineers, not quite so well known, but who still did important work, and who, to your special interest, were Baltimoreans. Admiral Melville was the designer of the machinery of the Oregon; Mr. Irving M. Scott, of the Union Iron Works, was its builder, and Capt. Robert W. Milligan was the chief engineer who made her reputation by bringing her around from the Pacific, and having her ready to play the chief role in the battle of Santiago. Milligan's is a case which I consider of special value to the young engineer, because it illustrates

how simple zeal, intelligence and faithfulness in the performance of duty lead to greatness. I know him well, and I think it extremely doubtful whether at any stage of his work he had the least idea it would render him famous. But there is no doubt that, although the design and building of the Oregon's machinery were worthy of all praise, it was Milligan's work, in his faithful and intelligent care of it, that enabled her to achieve the fame which has made her probably the most popular of all our naval vessels.

It is important also to note the numerous instances where men connected with engineering have risen to fame and great wealth from a very humble start and without any special opportunities in the way of influential friends. Mr. Carnegie, for example, was a very poor boy, and started as a telegraph messenger; Mr. Schwab, the president of the Steel Corporation, began his engineering work driving stakes for a surveying party; Mr. Frick, who was for many years the active head of the Carnegie Steel Company, started life as a clerk in a country store. These are all cases of men of world-wide fame, but I can speak from personal acquaintance with the leading men in the engineering department of my own company, some of whom receive salaries greater than that paid to a Cabinet officer, and they all began their active engineering work, after leaving the technical schools, as apprentices in the shop, where their work was in no way different from that of all around them. These cases all show that the opportunity exists, and it only remains for our young friends, in whose honor we are met to-night, to seize the opportunity as it comes to them.

The working days of the course are over for this year, and yet I feel that my address would have little value unless I attempted to give the graduates the benefit of some of the lessons which experience has taught us older men, and I shall endeavor to say a few words which I hope will be helpful to them in their future career.

First of all, I would urge them to be zealous and faithful in the performance of the work and duty which is right at hand, however simple and humble it may seem. This sounds a good deal like a platitude, but I have found that it is something which young men are, unfortunately, very apt to overlook; they see older men performing more important work and are apt to think, if they only had greater opportunities, they could do great things, but that the task allotted to them is so unimportant that it makes little difference whether it is well done or not. This is the greatest possible mistake. It is of the utmost importance that habits of faithfulness, zeal and careful attention to details should be acquired, and that anything like carelessness or superficiality should be avoided like the plague.

I have in mind the case of a brilliant engineer who showed, years ago, when I was associated with him, the fault of underestimating the duty assigned him, and always wanting to do greater things. It gave great offense to his employer, who, after he had parted from him, told me he would not employ him again in any capacity. He started in business for himself and for a time did very well, but some ten years later, when I inquired from a mutual friend as to how he was getting on, I found that this old idea of neglecting the simple things right at hand and only wanting to do great things had led to his failure. It is a fact, as you will find from personal experience, that employers and leading officials are always on the lookout for men of ability who have these good habits which I have mentioned, and they are not only ready, but anxious, to advance to higher positions those who prove themselves faithful and competent in lower ones.

Again, one of the things to be avoided most carefully is the fear of doing more than one's own share of work. The young man who spends his time looking at the clock so that he may be ready to quit work at the exact moment of its termination will find that this is a habit which will almost neutralize many other good ones. If the employe is determined that the employer shall get only his exact due, you may be sure that the employer will follow the same rule. I know personally of numerous cases of young men securing advancement largely because they were always ready for work at whatever time it came, and without regard to whether it was properly theirs or not.

Because I counsel this strict attention to one's own immediate duty it does not mean that ambition is to be discouraged or that one should be content with the low position in which he necessarily starts. On the contrary, the young engineer should endeavor, as far as he can, consistently with doing his own work properly, to make himself familiar with what is going on around him, so that when an opportunity for advancement comes he will be ready to take advantage of it. He should endeavor to master thoroughly the business he is in both by observation of surroundings and by reading the books that treat of it. No engineer can possibly keep abreast of the times unless he takes at least one good technical paper and reads it carefully. A scrapbook for the preservation of important articles, and a notebook in which to record new and interesting facts learned are also very desirable.

One of the most valuable of all the habits to be acquired by the young engineer is that of trained powers of observation. This may seem obvious, but it is a matter worthy of the most serious attention, and older men cannot too often urge its importance upon the young ones. An amusing illustration of the failure to use one's powers of observation came under my notice during my last cruise in the navy. We were taking in coal at a European port, where it was brought

alongside on scows heaped up in rectangular piles. The coal dealers being notorious thieves, it was necessary to buy the coal by measurement, and two of the young officers just out of the Naval Academy were detailed for this work. At the end of the day, when they made their report, it was obvious to some of the older officers, who had been on the ship some time and were familiar with the amount of coal which could be taken on board in a day, that their figures for the amount received were altogether too high. They went over their work very carefully, but could find no arithmetical error. On account of being the proud possessor of a calculating machine, and therefore being assumed to be a mathematical expert, I was called to see what was the trouble. I examined the figures, checked them and satisfied myself that the error was not one of arithmetic. In looking over these figures I noticed that the height of the piles in several cases was put down at more than six feet. Now, while I had personally had nothing to do with the coaling, I had happened to watch these young men while they were at work, and when they were standing alongside several of the piles I noticed that they could readily look over them, which, of course, showed that, as they were not giants, the piles could not have been six feet high. I asked them about this, and found that they could look over all of the piles. The trouble proved to be due to the use of a linen tape line for measuring, where the ring at the end had pulled out and a knot had been tied, so that the measurements were made from the one-foot mark. The young man who read off the measurements assumed that the other one deducted a foot from his reading each time, while the one who recorded thought the other man had deducted a foot from his reading before calling it off. Neither of them had taken the trouble to think for a minute when they were putting down the amounts at over six feet that it was an absurdity, because they had all the time been looking over the piles of coal.

This is only one of numerous instances which I could give. In this case no particular harm was done, because we had not yet paid for the coal, and the matter was easily adjusted. There is another story, however, of the civil engineer who designed a bridge which gave way with a train and caused the loss of a number of lives. The natural idea was that the bridge was too weak. The engineer steadily maintained that it was strong enough, and went back to look over his calculations, After secluding himself for several hours he came out of his room and said: "Curse that decimal point." The man with trained powers of observation and trained intelligence does not have to depend on mathematical calculations alone to be sure that his work is right. There are always other things with which comparison can be made, and the competent engineer never rests satisfied until his test of past experience and common sense has been applied.

This leads me to say that "common sense" is perhaps, as a natural gift, one of the rarest, and yet it is more important than almost anything else. Without it the finest mathematical training is almost valueless. What is really meant by common sense is well illustrated by the example I gave of measuring the coal piles. In other words, it is the bringing to bear on the problem which one has in hand of trained intelligence and comparison with general experience. We must, however, be reasonable and temperate in all things, and we must not assume that propositions are absurd simply because our experience has been along entirely other lines and we really are not able to judge. You have doubtless all heard of the story about the King of Siam, who, when told about ice, simply considered those who told him to be liars, because, never having seen such a thing as ice, he could not believe that it existed.

One point on which I want to lay considerable stress with our young friends is, that they must not become discouraged because they are not rapidly promoted. There are a number of cases to-day of very young men occupying positions of great prominence, so that there is perhaps a tendency on the part of graduates to feel that unless they do not attain to a high position at an early age they have made a failure. This is a great mistake; the cases which are so well known are the marked exception instead of being the rule. The rule is that the more important places naturally and rightfully go to the older and more experienced men. It is sometimes hard for a bright and capable young man to understand why an older one, whom he perhaps truly believes to have less theoretical information than himself, should be given a much higher position and be paid a much higher salary. The explanation is very simple; the older man is paid for his experience. This is something that can only come with time, and the young man is no more to blame for not having it than he is for being young. Therefore, as I have already said, the young man must go along faithfully with his work, acquiring habits of industry and attention to duty, and gaining experience so as to fit himself for the higher position when it is offered, as it certainly will be if he shows himself fitted for it.

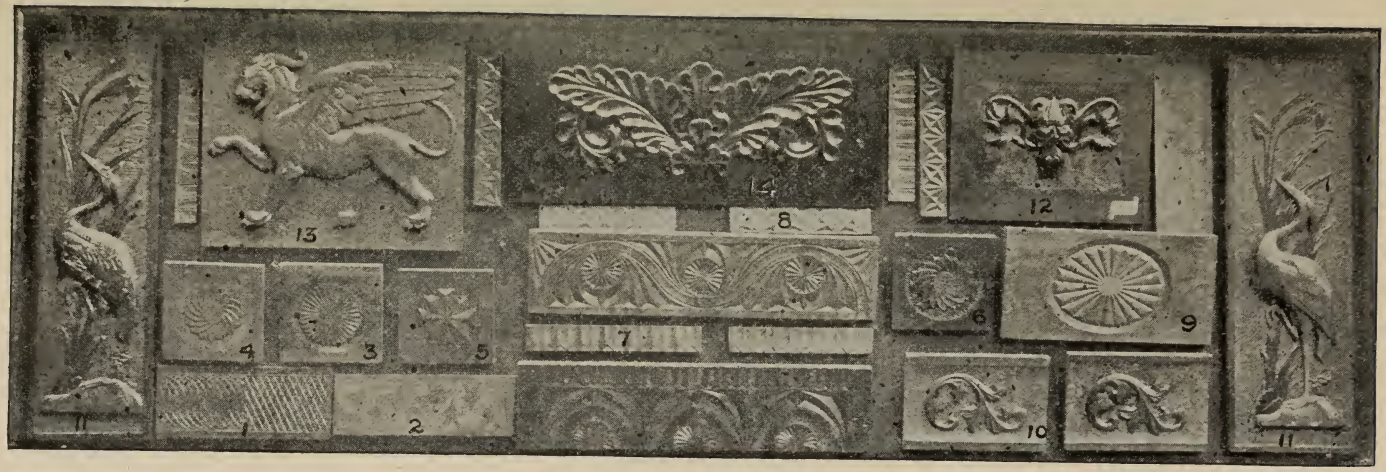
Much of what I have said is specially applicable to those of the graduating class who are about to go into active life, but the same general principles apply in further educational work as well. I do not know whether I have succeeded in impressing upon them the importance of the points to which I have called attention, and I can hardly expect that they will remember all of them. They are, however, worthy of most careful attention, and are the result of my sincere desire to give them the benefit of my own experience and that of other older men, to the end that by having the things which should be done pointed out they may strive to do them, and, on the other hand, they may avoid the things which would be mistakes.

And now, my young friends, I congratulate you most heartily on the successful termination of your year's work and the beginning of a season of recreation before you start in again in new fields. I congratulate you most heartily upon your choice of a profession, and, as one of the older members, welcome you into its ranks. The members of this profession have done a great deal to make life happier and more comfortable and to benefit humanity generally. It may be the good fortune of some of you to write your names along with those of Morse, Whitney and Westinghouse as great inventors, or with that body of great engineers who have done notable things; but even if you do not become famous, there is still plenty of important work for you to do, and you can do that well. The poet has expressed this idea beautifully in the well-known lines:

"Honor and shame from no condition rise;
Act well your part: there all the honor lies."

You are citizens of the grandest country in the world. You have entered the ranks of the greatest of the professions. You have every reason to be filled with enthusiasm. Go forward in your chosen work with courageous hearts, counting with confidence on that success which is the reward of ability and steadfastness.—*From the Architects and Builders Journal, July, 1903.*

[Three years ago the address to the graduates of the Baltimore Polytechnic Institute was delivered by Capt. Richmond P. Hobson, who is recognized as one of the ablest of the naval constructors of the navy. Last year Admiral George W. Melville, Chief of the Bureau of Steam Engineering, whose reputation as a marine engineer is world-wide, honored the Institute in a similar manner, and at the commencement on June 16, this year, Mr W. M. McFarland, formerly Chief Engineer, U S. N., but now Vice-President of the Westinghouse Electric Co., whose address we publish above, gave to the graduating class the benefit of his experience as a guide for their future. The fact that three gentlemen so distinguished in their several spheres should not only have consented to favor the Institute on these occasions, but have also felt it an honor to do so, speaks volumes for the esteem in which the Institute is held by those most competent to judge of its merits, and should arouse feelings of pride in the breast of every citizen of Baltimore and be a powerful factor in the increased support of the Institute by the municipal authorities.—EDITOR.]



WOOD CARVING.

SOME OF THE EXAMINATION PAPERS SET IN JUNE, 1902.

STEAM ENGINEERING.

Fourth Year Class, May 29, 1902.

1. Deduce the general expression for the value of the mean pressure of any gas working in a cylinder, the gas expanding according to any law. When the expansion is according to Boyle's Law, what is then the expression for the mean pressure?

2. Diameter of cylinder 9″, stroke 10″, clearance 7%. Initial absolute pressure 95 lbs., back pressure 17 lbs., cut-off 28%, clearance 7%. Release takes place at 90% of stroke, and the exhaust closes after 70% of the return stroke is completed. The expansion and compression following Boyle's Law, you are required to construct the expected indicator diagram, and to find the terminal pressure p_2, the terminal pressure of compression p_c, and the mean effective pressure p_e. Scale of stroke ½, and of pressure 40. If the engine is to make 365 revolutions per min., what I. H. P. may be expected?

3. Upon what do the diameter of the cylinder of an engine and the mean pressure to be used depend? What are the principal causes that make the mean pressure obtained less than that theoretically due to the initial pressure and ratio of expansion? What are the mean pressure factors used for modern stationary engines? for compound engines? for triple-expansion marine engines?

4. Required the dimensions of a two-cylinder compound engine to develop 1,500 I. H. P. Piston speed 850 feet per min., absolute initial pressure 110 lbs., absolute back pressure 3 lbs., cut-off in H. P. cylinder ½ stroke, H. P. clearance 10%, and that of L. P. 9%. Use a mean-pressure factor of .7, and find Naperian logs. by multiplying common logs. by 2,303. After finding the cylinder diameters you will select a suitable stroke, and then find the number of revolutions the engine must make per min. Find also at what part of the stroke the steam should be cut off in L. P. cylinder.

5. Into what classes are steam boilers grouped? Give a general description of a Scotch boiler and of a sectional boiler. What advantages are claimed for the sectional boiler? Mention some disadvantages. In the design of a shell boiler what values do good practice assign to the following ratios, viz.: $\frac{\text{I. H. P.}}{\text{Grate Surface}}$, $\frac{\text{Grate Surface.}}{\text{Heating Surface}}$, what is the relation between the steam space and the I. H. P? What form of furnace is universally used in shell boilers?

6. The exterior diameters of the tops of the corrugations of a furnace flue are 39″ and at the bottom 36″. The pressure to be carried is 200 lbs. per sq. in. What thickness of flue should be use?

Find the thickness of plates required for a boiler shell to be worked at a pressure of 160 lbs. per square inch. Diameter of shell, 8 ft.; efficiency of riveted joint, 89%; stress in plates, 5 tons per square inch.

7. Length of connecting rod 40″, stroke 20″, travel of valve 4″, lead angle at top 9°, mean cut-off 70%, and release top and bottom 1-10 from end.

Construct a Zeuner diagram and find the steam lap, the exhaust lap, the steam opening, the exhaust opening, the lead, and the angular advance of the eccentric.

Scale of crank diagram, ¼, and of valve diagram, full size.

MECHANICS.

Fourth Year Class, May 26, 1902.

1. A beam 20 ft. long, weighing 25 lbs. per lineal foot, is supported at the ends. Where should a weight of 600 lbs. be placed in order that the pressure on the right support should be ⅔ that on the left support?

2. BCDO is a flat plate, right angled at C, and having the following dimensions: BC=18″, CD = 15″, DO =12.5″, and the perpendicular from O on BC measures 18.5″. Construct the figure to a scale of 1.5 inches to the foot, and locate graphically the centre of gravity of the figure.

3. Find the centre of gravity of a trapezoid.

4. An equilateral triangle rests on a square, and the base of the triangle is equal to a side of the square; find the centre of gravity of the figure thus formed.

5. The length of the power arm is 15″; find the distance between two consecutive threads in order that the mechanical advantage may be 30.

6. If the force required to draw a train of cars on a level railroad be $\frac{1}{200}$th part of the load, find the force required to draw it up a grade of 1 in 56.

7. A body weighing 6 lbs. is placed on a smooth plane which is inclined at 30° to the horizon; find the two directions in which a force equal to the weight of the body may act to produce equilibrium. Also find the pressure on the plane in each case.

8. A uniform beam has one end resting against a rough vertical wall, and the other end against a rough horizontal plane. The coefficient of friction between the beam and wall is ⅔, and between the beam and horizontal plane it is ⅜. Find the inclination of the beam to the horizon when it is about to slip.

9. A crane has a vertical post 9 ft. high and a boom 18 ft. long. The angle between the boom and post is 45°. Find by calculation the tension on the tie and thrust on the boom when a load of 6 tons is suspended from the extremity of the boom. Prove the accuracy of your results by solving the question graphically by means of the triangle of forces: what is the pull on the top of the post?

10. A boom AO is supported by a pin in a vertical wall OB at O, and at the end A by a guy AS running to the wall and making an angle with it of 30°. At the end of the boom is suspended a weight of 500 lbs. The weight of the boom is 300 lbs., the distance SO is 10 ft., and the length of the guy is 20 ft. Find the tension on the guy, and the portions of the thrust of the boom sustained by the pin and by the wall.

MECHANICS OF MATERIALS.

Fourth Year Class, June 4, 1902.

1. Define stress. What kinds of direct stresses are produced in bodies by exterior forces? Define elastic limit, factor of safety, resilience. A bar 2 inches in diameter ruptures under a tension of 173,000 lbs.; what is its ultimate strength?

2. To what character of loads is the piston of a steam engine subjected? The cylinder of an engine is 9 inches in diameter, and the steam pressure per square inch 100 lbs. If the piston rod is to be of steel, whose ultimate strength is 70,000 lbs. per square inch, what should be its diameter, allowing the proper factor of safety?

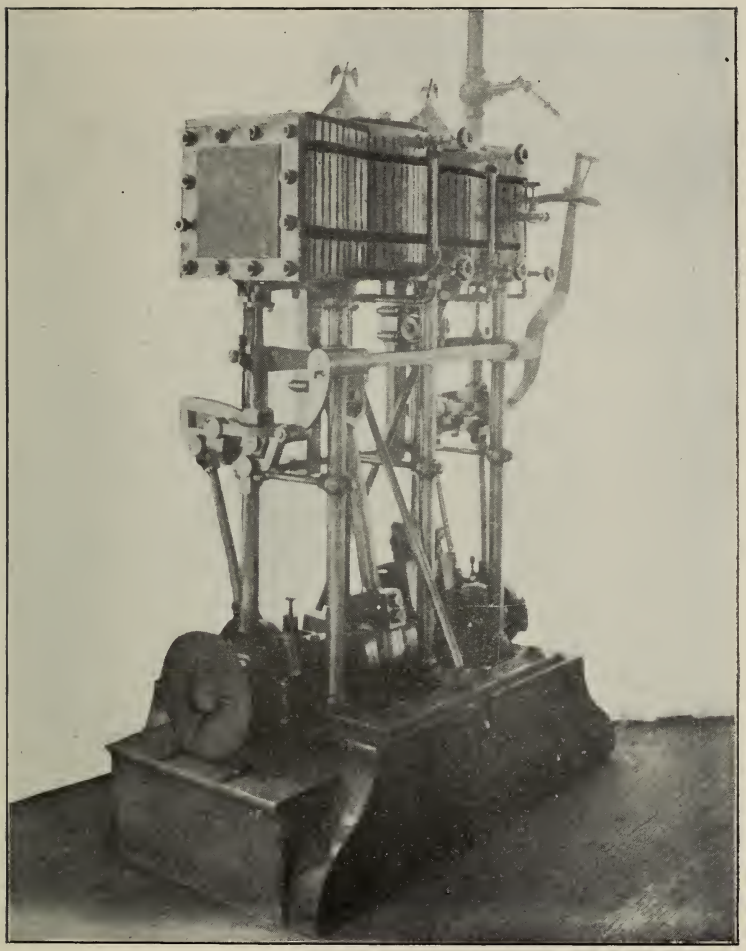
3. Illustrate graphically how a bending moment is produced in a bar. To what is the bending moment at any section of a beam equal? A simple beam 12 feet between supports has a load of 200 lbs. at 4 feet from the left end and a load of 475 lbs. at 2 feet from the right end: find the bending moment at a section 5 feet from the right end.

4. Compute the moment of inertia of a T section whose depth is 4 inches, width of flange 3.5 inches, thickness of stem $\frac{3}{8}$ inch, and thickness of flange $\frac{3}{8}$ inch. Compute also the modulus of the section.

5. Find the polar moment of inertia and the radius of gyration of a circle treated as a thin lamina.

6. When does a sheer stress exist in a beam? To what is the sheer at any section of a beam equal? Construct the sheer and bending moment diagrams of the beam of Question 3, and determine therefrom the bending moment at the section 5 feet from the right end.

7. The flat top of the combustion chamber of a boiler is to be braced by girder stays. The area supported by each girder is 28″x8″, and the pressure per square inch 200 lbs. Each stay is to have three bolts symmetrically placed. The girders are to be arranged in pairs, and, assuming the width of each to be $\frac{7}{8}$″, you are required to find their depth, taking the working stress as 8,500 lbs. per square inch.



COMPOUND ENGINE.

Built by students after design of the Bureau of Steam Engineering, Navy Department.

8. Find the diametral dimensions of a hollow steel shaft to transmit 8,000 I. H. P. at 115 revolutions per minute, the stress on the exterior circumference not to exceed 8,000 lbs. per square inch, and the interior diameter to be 98% of one-half the exterior diameter. Find also the diameter of a solid shaft to transmit the same power under the same conditions. Compare the weights of the shafts, and prove that they are equal in strength.

9. In a rolled steel beam, symmetrical about the neutral axis, the moment of inertia of the section is 72 inch units. The beam is 8 inches deep, and is laid across an opening of 10 feet, and carries a distributed load of 9 tons. Find the maximum fibre stress, also the central deflection, taking E at 13,000 tons per square inch.

MATERIALS OF ENGINEERING.

Fourth Year Class, May 20, 1902.

1. Mention some of the metals used by the engineer in forming alloys. Describe the properties of copper, and state some of the uses of this metal. Name the metals and, approximately, their proportions used in forming the alloys known as common yellow brass, gun metal, navy composition, steam metal, manganese bronze, phosphor bronze, spelter, and babbitt metal.

2. In the classification of iron and steel, mention the metals known as malleable, semi-malleable, and non-malleable.

3. By what process is cast-iron reduced from the ore? How is the quality of cast-iron affected by the various methods and different fuels employed in its reduction? How is pig-iron usually graded? Name some of the brands of pig-iron. From what source does cast-iron absorb much carbon? In what two forms does carbon unite with cast-iron? What is the difference in the character of cast-iron containing a high percentage of graphitic carbon and that containing a high percentage of combined carbon? How is the fluidity of cast-iron affected by the amount of carbon it contains?

4. Describe the effect of slow cooling and of sudden cooling on cast-iron when in the mould. How are the color and appearance of the fracture of cast-iron affected by the amount of graphitic carbon present? Can cast-iron be united to itself, or to wrought-iron, or to steel? Describe how a large casting may be mended. How can cast-iron be made partly malleable? Where are malleable iron castings used in engineering work? Describe the process of inspecting iron castings. Name the different physical tests for cast-iron. Sketch and show dimensions of the conventional form of test-piece used for the tensile, transverse and compressional tests of cast-iron.

5. Name the process by which cast-iron is converted into wrought-iron. When the conversion is complete, by what name are the pud-

dled balls known? After being compressed under the steam hammer and passed through the rolls of a mill, how are the bars designated? Name the element which is nearly eliminated from the iron by the puddling process. Explain how slag affects the quality of wrought-iron. What effect on wrought-iron has an excess of phosphorus and of sulphur? What are the special properties of wrought-iron? Name some of the brands of wrought-iron. Name the different physical tests for wrought-iron, and make a sketch showing the form and dimensions of the piece used for the tensile test.

6. On what do the properties of steel partly depend? What impurities, other than carbon, are contained in steel? When the percentage of these impurities is high, what effect does each have on the steel? Explain the method of making high-grade steel. By what process is mild, or structural, steel produced? In the production of steel for engineering purposes, which of the two processes is preferable, and for what reasons? Explain what is meant by the acid and by the basic processes. Define spiegeleisen and ferro-manganese. Define semi-steel, nickel-steel, chrome-steel, and tungsten-steel. How are the strength and ductility of steel affected by an increase of carbon in its composition? Describe the different physical tests for structural steel. Make a sketch showing the forms and dimensions of the conventional test-pieces used for testing steel for boiler plates, for shafts, and for piston-rods. What tensile strength and elongation are required of steel used for plates that are to be flanged, and for boiler rivets, shell plates, steel castings, shafting, and piston-rods?

DIFFERENTIAL CALCULUS.

Fourth Year Class, February 21, 1902.

Questions 1 or 2, 3, 6 or 7, 9, and one other are required.

1. (a) If $f(x) = 2x\sqrt{1-x^2}$, show that $f(\sin\frac{x}{2}) = \sin x$.

(b) If $f(x) = \log\frac{1-x}{1+x}$, show that $f(x)+f(y)=f(\frac{x+y}{1+xy})$.

2. (a) Give the definition of a derivative. (b) Of what steps does the process of differentiating $f(x)$ consist?

3. Derive the formula for $\frac{d}{dx}(\sin u)$.

4. Develop $\tan x$ in a power series of x.

5. Evaluate (a) $\frac{e^x - e^{-x}}{\sin x}$ when $x = 0$; (b) $\frac{x^4 - 2x^3 + 2x - 1}{x^6 - 15x^2 + 24x - 10}$ when $x = 1$.

6. The diameter of a cylindrical tree is d. Find the strongest beam that may be cut from it, assuming that the strength is proportional to the breadth multiplied by the square of the thickness.

7. A rectangular court is to be built so as to contain a given area; a wall already constructed is available for one of the sides. Find its dimensions so that the least material may be required.

8. Show that the exponential curve $y=ae^{\frac{x}{c}}$ has a constant subtangent.

9. Given $y^2=4ax$; find $\frac{ds}{dx}$ and $\frac{dV}{dx}$.

10. Find the radius of curvature: (a) in the catenary $y=\frac{c}{2}(e^{\frac{x}{c}}+e^{-\frac{x}{c}})$;

(*b*) In the exponential curve $y=ae^{\frac{x}{c}}$.

INTEGRAL CALCULUS.

Fourth Year Class, June 2, 1902.

1. Prove (a) $\int_a^b f(x)\,dx = -\int_b^a f(x)\,dx$;

(b) $\int_a^b f(x)\,dx = \int_a^c f(x)\,dx + \int_a^b f(x)\,dx$.

2. Find the curve for which the length of the subnormal is proportional to the square of the length of the abscissa. Determine the curve so that it shall pass through the origin and point (3, 4).

3. Write twenty fundamental formulæ of integration.

4. Derive the formulæ $\int cosec\ u du$, and $\int \frac{du}{u^2-a^2}$.

5. Find $\int \frac{dx}{x^2\sqrt{a^2-x^2}}$, and $\int \sqrt{a^2-x^2}\,dx$.

6. Integrate (a) sin y sec^2 xdx + tan x cos ydy;

(b) cosec x cos ydy — cosec x cot x sin ydx.

7. Find the volume of the prolate spheroid generated by the revolution of the ellipse about the x-axis.

8. Find $\int sin^{\frac{2}{3}} x\ cos^5 dx$, and $\int \frac{sin^3 x}{cos^7 x}dx$.

9. Find $\int_2^3\int_1^2\int_2^5 xy^2 dz\,dy\,dx$, and $\int_0^{11}\int_0^{a(1+\cos x)} r^2 \sin x\,dx\,dr$.

10. Find the volume of the elliptic paraboloid $2x=\frac{y^2}{b}+\frac{z^2}{c}$ cut off by the plane $x=a$.

EXAMINATION IN ELECTRICITY.

Fourth Year Class, June 6, 1902.

1. State cause of trouble and temporary remedies, if any, when generator exhibits following defects:

(*a*) Heavy sparking, sparks appearing as a band of light around commutator; (*b*) Fall in E. M. F., heating, sparking and extra pull on engine; (*c*) Sparking and low potential, but no extra pull or heat except at commutator, and that only of such intensity as to be attributed to heat produced by sparks. (*d*) The E. M. F. only a few volts and the generator refuses to build up.

2. Explain why a regulator must be used on a series motor operated on a constant current circuit. Also show how same method of winding may be used on constant potential circuit and be almost self-governing.

3. What number (B & S) wire should be used as a feeder for supplying three buildings situated at 300, 350 and 450 feet, respectively, from generator and having 90, 75 and 100 lamps, respectively, each lamp requiring 60 watts, E. M. F. 110, and drop being 4% of lamp voltage? Also give sizes of mains to each building.

4. State clearly, using diagram, the effect of increasing the load of a transformer.

5. Explain the use of an equalizer in the operation of compound wound generators. Give directions for throwing in an additional generator, giving reasons for each step.

6. A line 15 miles long shows a ground. Give diagram for locating distance of ground from testing station by loop method. Assuming the ground is 5 miles distant, insert in diagram readings to correspond.

7. Show connections for finding insulation resistance of lighting circuit, both for insulation between conductors, and between conductors and ground.

On a 125 volt circuit, what would be the readings if insulation resistance between conductors was 100000 ohms and between each conductor and ground 150000 ohms? Voltmeter resistance 20000 ohms.

8. Outline principal connections made by controller of electric car. Why is rail bonding necessary? How is the shock upon the gearing, produced by the starting of the motor, partially prevented?

9. Give sketch of connections of simple telephone line with two stations. Give outline of various operations in and out of exchange (central energy) when call is made for connection with another subscriber.

10. Describe the controller of the Brush arc-light generator. Explain method of *detecting* ground in a high potential *alternating* circuit.

EXAMINATION IN CHEMISTRY.

Fourth Year Class, May 12, 1902.

1. Describe method of separating bases into seven classes, as described in Eliot and Storer's Manual, giving reagents for each class.

2. How are carbonates distinguished from other effervescing compounds? How are sulphates distinguished from other substances precipitated by barium chloride?

3. Describe method of making test for quantity of silver in solution by gravimetric method.

4. Write formulæ indicating reactions in treatment of mercuric chloride with sulphuretted hydrogen, dissolving precipitate in aqua regia, and depositing metallic mercury by copper.

5. Make calculations for amount of salt to be dissolved in 1,000 c. c. of water to precipitate 5 centigrams of silver to 1 cu. cm. of solution. How much silver nitrate would be in a solution which requires 40 c. c. of solution to precipitate it? How do you know when precipitation has ceased? The combining weights of Ag, N, O, Na, and Cl are respectively 107, 14, 16, 23 and 35.

6. Give outline of test for per cent. of carbon in steel. State object of various compounds in absorbing train.

7. An analysis in the laboratory of a given solution. (This question has the value of 30% of the entire examination.)

EXAMINATION IN STEAM ENGINEERING.

Third Year Class, May 26, 1902.

1. Make six sketches showing the action of the slide valve in distributing steam in the cylinder during a stroke of the piston, enumerating the events of the stroke.

2. Define lap and lead. For what purposes are lap and lead given to a valve? What types of engines require link motions? Why is the Stephenson link particularly well adapted to locomotives? Explain in general terms the action of a shaft governor and shifting eccentric in automatically cutting off the steam.

3. Length of the connecting rod 5 feet, stroke 30 inches. Find the position of the piston, measured from each end of the stroke, when the crank makes an angle of 150° with the head dead point.

4. The piston is at the head end of the stroke. Angular advance o the eccentric, 50°. Length of eccentric rod, 50 inches. Diameter of the shaft, 9 inches, and of the eccentric disc, 15 inches. Thickness of strap, 1.25 inches. Thickness of strap lugs, 1.25 inches, and their length, 2 inches. Width of rod at strap end, 4.5 inches, and at valve end, 2.5 inches. Travel of the valve, 4 inches. Diameter of eye at valve end of rod, 2 inches. Make sketch to a scale of 1.5 inches to the foot.

State briefly the advantages claimed for the stage expansion engines.

5. What does the number on the spring of an indicator indicate? From a given indicator diagram how would you tell whether it is from a condensing or a non-condensing engine? Explain explicitly that the expression $\frac{pLaN}{33\,000}$ gives the horse-power of an engine.

6. The triple-expansion engines of the U. S. S. Albany are 31″, 46″, 70″ x30″. Clearance of the H. P. cylinder 18% and of the L. P. cylinder 15%. On her trial trip the H. P. cut-off was 21.8″ from commencement, and the initial absolute steam pressure, 165.7 lbs. Find the total ratio of expansion and the terminal pressure in the L. P. cylinder. Prove the accuracy of your results by showing that the calculated volume of steam in the L. P. cylinder and clearance at the end of the stroke is just equal to the volume of the L. P. cylinder and its clearance. The specific volume of steam at 165.7 lbs. is 2.7319 cubic feet, and the specific volume of the steam at the L. P. terminal pressure may be found by the formula $pv^{\frac{17}{16}}=482$.

TRIGONOMETRY.

Third Year Class, June 6, 1902.

1. (*a*) Derive the functions of (180° + x) in terms of those of x.
   (*b*) Derive the functions of (270° — y) in terms of those of y.
2. (*a*) sin (x —y) = ? (*b*) cos (x — y) = ?
3. Find the functions of half an angle.
4. Prove the law of tangents.
5. The two diagonals of a parallelogram are 5 and 6, and the angle they form is 49° 18′. Find the sides.
6. If the sides of a triangle are 4, 3, and 6, find the sine of the angle opposite the side 6.
7. In the system of logarithms whose base is 20 find the logarithm of $\frac{1}{10}$.
8. State Napier's Rules. Write the formulae relating to right spherical triangles.
9. Prove $\tan^2(45° - \frac{A}{2}) = \tan\frac{c-a}{2}\cot\frac{c+a.}{2}$
10. Given $a = 50°$, $b = 36°\ 54'\ 50''$, $= C = 90°$; find c, A, and B.

ANALYTIC GEOMETRY.

Third Year Class, June 2, 1902.

1. Construct the locus $y = \sin x$.
2. Find the equation of a straight line in terms of its intercepts.
3. Find the angle between $y = mx + c$ and $y = m'x + b$. Show the relation between m and m' if the lines are perpendicular.
4. Find the equation of the tangent to the circle $x^2 + y^2 = r^2$ at the point (x', y').

5. Find the general form of the polar equation of the circle.

6. What does the equation of the equilateral hyperbola, $x^2-y^2=a^2$, become if the axes are turned through—45°?

7. Find the equation of the ellipse, having given the foci and the constant sum $2a$.

8. Draw a tangent and a normal through a given point on an ellipse.

9. Prove the equation of the director circle of an hyperbola to be $x^2+y^2=a^2-b^2$.

10. Define the cycloid and find its equation.

LITERATURE—Third Year Class.

Paper Set in February, 1902.

I.—Define: Drama; Epic; Tragedy; Comedy.

II.—Define: Complicating Forces; Resolving Forces; Climax; Catastrophe.

III—Give an outline for analyzing a drama.

IV.—Enumerate the complicating and the resolving forces in "Macbeth," and locate the climax.

V.—From what source did Shakespeare get the story of "Macbeth," and what changes did he introduce in dramatizing it?

VI.—Discuss the metrical forms found in the play. Is there any prose? Discuss.

VII.—What is the general opinion as to the authorship of the play, i. e., the authorship of the whole play?

VIII.—Mention one or two events or speeches that are intended to prepare for more important events.

IX.—Write a brief sketch of the life of Shakespeare.

X.—Explain:

(a) "Paddock calls.
Anon."

(b) "Like valour's minion, carved out his passage."

(c) "To all and him we thirst,
And all to all."

(d) "Ere to black Hecate's summons
The shard-borne beetle with his drowsy hums
Hath rung night's yawning peal——"

(e) "And some I see
That two-fold balls and treble sceptres carry."

XI.—(a) When does Lady Macbeth's *work* in the play end? (b) What characters has Shakespeare made character-contrasts? (c) Is there a comedy element? If so, where? Why at that point? (d) Who is the dominating character in the earlier part of the play, and who in the latter part?

XII.—Write a theme of not less than three paragraphs upon one of the following subjects:

(a) Lady Macbeth as Queen.
(b) Lady Macbeth as Wife.
(c) One of the Minor Characters.

Paper Set in June, 1902.

I.—When, where, and in what political situation was the speech on "Conciliation" delivered? Into what divisions have we resolved it? What was the orator's proposition? What, his purpose? How did he propose to carry his purpose into effect?

II.—Mention three examples of allusion or of other figures of speech.

III.—Outline the "Statement of Facts."

IV.—In the early part of the speech, what reasons does Burke allege against the employment of force? Had he chosen to place these reasons elsewhere, what would have been the proper place for them? Why?

V.—Write a short sketch of Milton's life.

VI.—What persons, places, or events are alluded to in the following lines:

(a) "For Lycidas is dead, dead ere his prime."
(b) "For we were nursed upon the self same hill,
Fed the same flock by fountain, shade, and rill."

VII.—Explain or comment upon the meaning of the following words or phrases:

(a) *Once more*, in "Yet once more, O ye laurels——;" (b) buxom; (c) Friar's lantern; (*d*) weeds of peace; (e) massy proof; (f) curfew; (g) storied windows richly dight; (h) ruth; (i) darkest grain.

VIII.—What do you consider Milton's relations to the speakers in "L'Allegro" and "Il Penseroso" to be? Discuss briefly.

IX.—(a) Give a concise description of a Mask. (b) What do you consider the most dramatic scene in "Comus"? Why?

X.—Quote a passage of not less than ten verses from each of the poems we have studied.

SPECIMEN ENTRANCE EXAMINATION PAPERS SET FOR PUPILS OTHER THAN THOSE ENTERING FROM THE GRAMMAR SCHOOLS.

Spelling and Penmanship.

Writing from dictation a paragraph or two of some standard text—Irving's Rip Van Winkle or Bancroft's United States History.

Grammar.

I.—Use each part of speech in a different sentence, indicating the part of speech used in each sentence by underscoring and naming it.

II.—Define and give an example of a simple sentence, of a complex sentence, and of a compound sentence.

III.—Parse the underscored words in the following sentence:

"By not heeding the counsels of our elders, how often do we lose what we should gain."

IV.—Analyze the following sentence:

"If we send the sailors a message in time, they will help us when the savages attack us."

V.—Write sentences illustrating the correct use of any perfect tense of the following verbs: sit, set, seat, lie, lay, write, go.

Composition.

The subject set is a description of some well-known place or object, or an account of some historical event.

United States History.

I.—What country was each of the following explorers serving when he came to America, and what territory did he discover or explore: Columbus, De Soto, Drake, Cartier.

II.—Name the principal causes and the principal results of the French and Indian War.

III.—State several causes of the Revolutionary War.

IV.—What were the "Articles of Confederation", and why, and by what, were they superseded?

V.—What is meant by "The Missouri Compromise"?

VI.—Give a short account of the "Nullification" incident.

VII.—What was the most important result of the Mexican War?

VIII.—Name the principal causes of the Civil War. Who commanded on each side at Gettysburg? Why was the battle of Gettysburg so important?

IX.—What reason did the United States assign for going to war with Spain in 1898? What territory did the United States acquire as a result of that war?

Arithmetic.

1. Face of note, $450; date, Jan. 4, 1889; time, 30 days. Find the proceeds of the note if it is discounted at bank on February 1, at 6%.

2. Two vessels sail from the same port; one due north at rate of 8 miles per hour, and the other due east at rate of 6 miles per hour. How far are they apart at the expiration of 5 hours?

3. How many lengths of rail of 30 feet each will be required to lay a double track of 10 miles, allowing $\frac{7}{100}$ % for expansion?

If 10% of the power of a 40 horse-power engine is lost in transmission and still 20% more power than is required is furnished to a machine, what power is required by the machine?

5. A piece of land 35 rods long and 7 rods wide is divided into 5 square lots. What will be the cost of the boundary and the cross fences at $2.12½ per rod?

Algebra.

1. (a) Simplify $\frac{x+2}{2} - \frac{x}{x+2} - \frac{x^3-2x^2}{2x^2-8}$.

(b) If $R = 5a + 4b - bc$, $S = -3a - 9b + 7c$, $T = 20a + 7b$, $U = 13a - 5b + 9c$, find value of $R - (S + T) + U$.

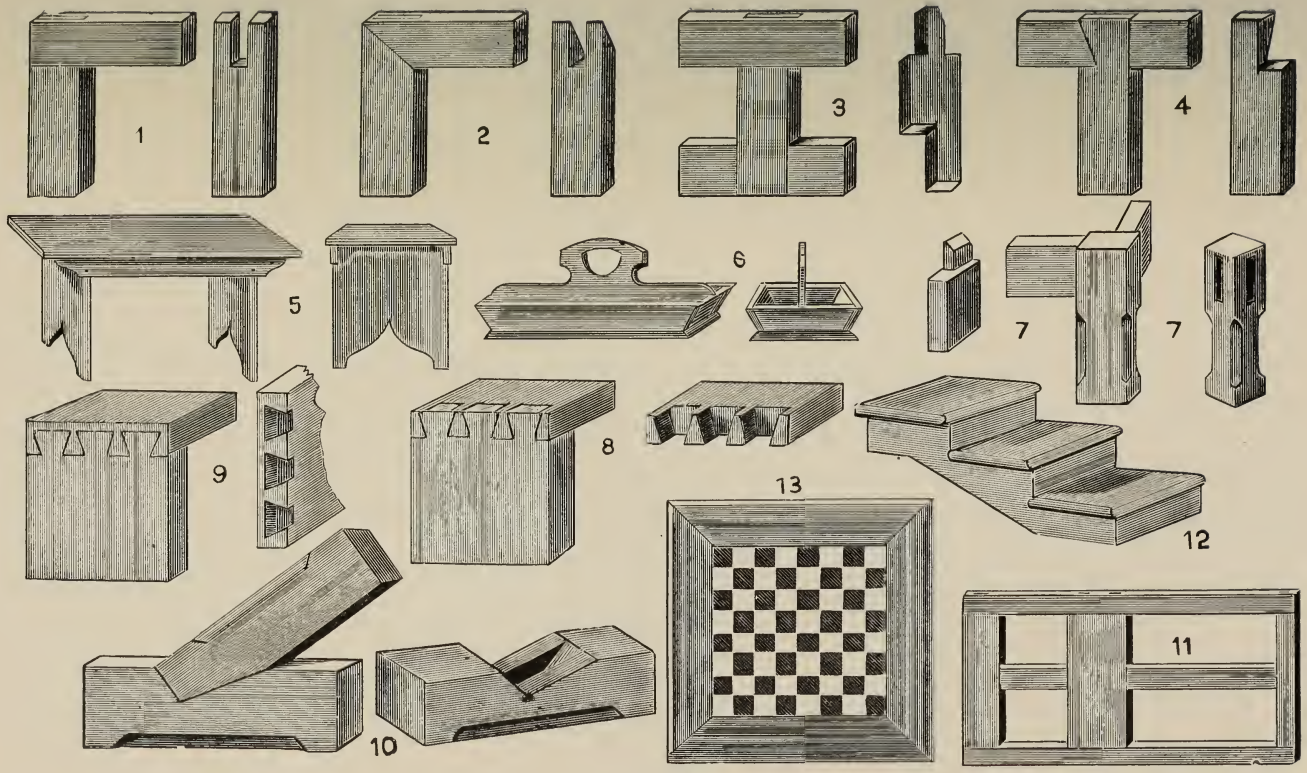
2. There are 150 coins, consisting of half-dollars and quarters, in a bag. If the value of the coins is $58.50, find the number of each kind.

3. Given $\frac{7+x}{5} - \frac{2x-y}{4} = 3y - 5$, $\frac{5y-7}{2} + \frac{4x-3}{6} = 18 - 5x$, find the values of x and y.

4. Forty-six tons of goods are to be carried in carts and wagons, and it is found that 20 wagons and 14 carts, or 13 wagons and 9 carts will be required. How many tons can each vehicle carry?

5. Separate into simplest factors: $x^2 - xy - 6y^2$; $x^6 - a^6$; $8x^2 + 13x - 6$.

6. What is the value of x in the equation $\frac{x-3}{x+4} + \frac{x-4}{2(x-1)} = \frac{1}{2}$?



CARPENTRY.

CATALOGUE OF STUDENTS.

(Corrected to December 31, 1903.)

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Geo. F. W. Sims.

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Emanuel Fritz,
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J. Lyell Gressitt,
P. Henry Harrison,
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Leon Small,
Oscar E. Smith,
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Louis A. Witte,
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Alexander H. Woollen.

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Hawley Bittle,
George W. Boettinger, Jr.,
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G. Herman Carl,
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Wilbur C. Jackson,
Reynolds K. Johnson,
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George Foster Maynard,
Carl Frederick Meyer,
Sidney T. Mitchell,
Harry Murray,
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Ferdinand Oppenheimer,
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Thomas J. Purvis,
Charles J. Rasch,
Stanley J. Reynolds,
John T. Ridgely,
Otho Ridgely,
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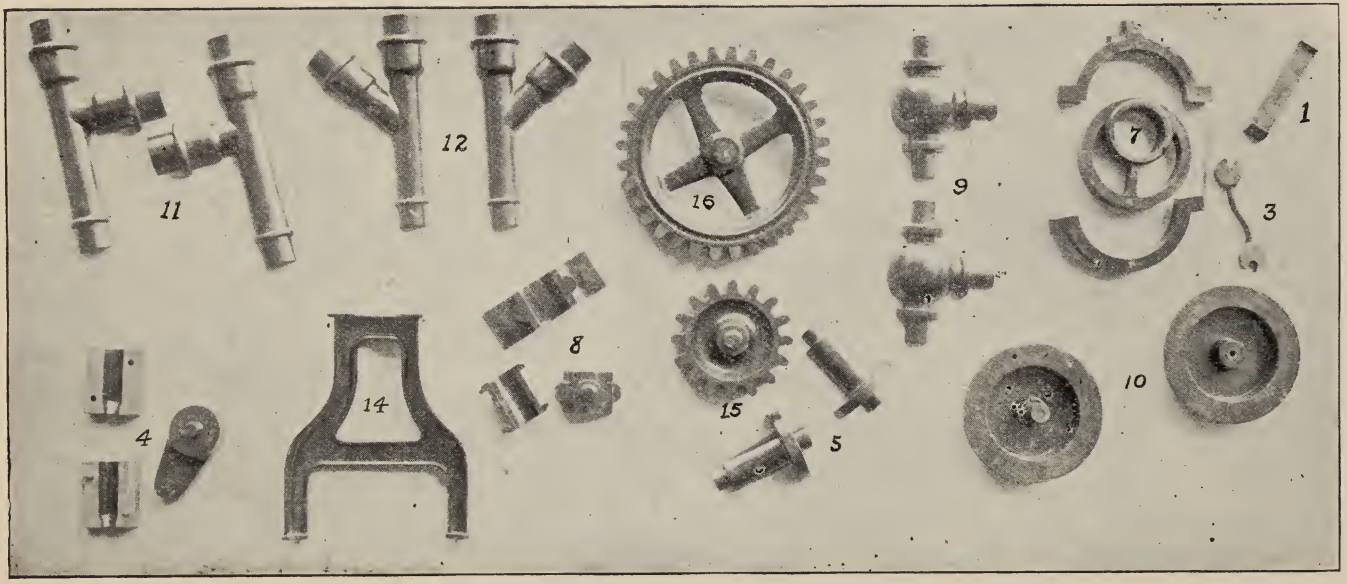
T. Leonard Walter,
Raymond M. Weaver,
William B. Weaver, Jr.,
T. Preston Webster,
George F. Wennagel,
George Frederick Wieghardt,
Walter Bruce Wills,
R. Horatio Wright,
E. Pinkney Wroth.



PATTERN WORK.

FIRST YEAR—D CLASS—209 MEMBERS.

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Theodore Ascherfeld,
Ludwig Aull,
Harry C. Ball,
Emil G. Bauersfeld,
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Emil Sedlacek,
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Jerome B. Wolf,
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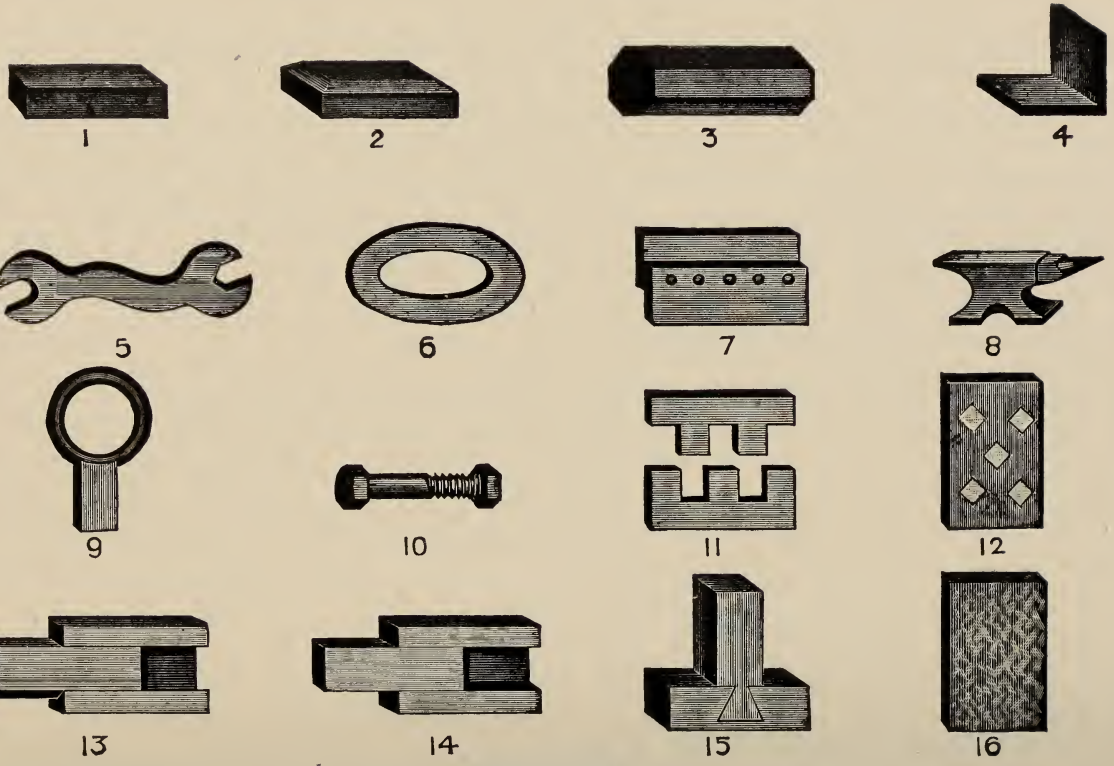
Julius Zieget,
August Zimmerman,
C. Elmer Walter,



VISE WORK.

CLASS ORGANIZATIONS.

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Vice-President ..... Milton Kraemer,
Secretary ..... George F. W. Sims.

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Vice-President ..... Joseph Bowes, Jr.
Secretary ..... Marion V. Bailliere.
Treasurer ..... Daniel J. Leary.

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Vice-President ..... John C. Newman.
Secretary ..... George F. Wennagel.
Treasurer ..... Charles A. Baldwin.

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Vice-President ..... Guy L. Hess.
Secretary ..... Howard G. Lanahan.
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Sergeant-at-Arms ..... J. Ralph Bolgiano, '07.
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Treasurer ..... A. K. Brumbaugh, '04.
Board of Governors ..... Daniel J. Leary, *Chairman.*
John McDonald Reid, P.G., '04.
Alexander H. Woollen, '04.
Edward Rowland Dawson, '06.
Frank H. McCormick, '07.

FOOTBALL.

The football season of 1903 was one of the most successful in the history of the Institute. Under the management of Louis Bennett, '06, eight games were played, resulting in three victories, three defeats, and two ties.

The line-up of the team was:

Dawson	Right End.
Harrison	Right Tackle.
Reynolds	Right Guard.
Stewart (Luby)	Centre.
Schnepfe	Left Guard.
Leary	Left Tackle.
Mason (Tauszky)	Quarter Back.
Brumbaugh	Right Half Back.
Bowes (Captain)	Left Half Back.
Carl (Hess)	Full Back.

Substitutes: Aldridge, Moore, Heubeck, Chase.

The following is a summary of the games played:

Oct. 10, at Belair; Polytechnic, 0, Belair Athletic Club, 0.

Oct. 14, at Union Park; Polytechnic, 6, Boys' Latin School, 0.

Oct. 24, at College Park; Polytechnic, 0, Md. Agricultural College 2nd, 5.

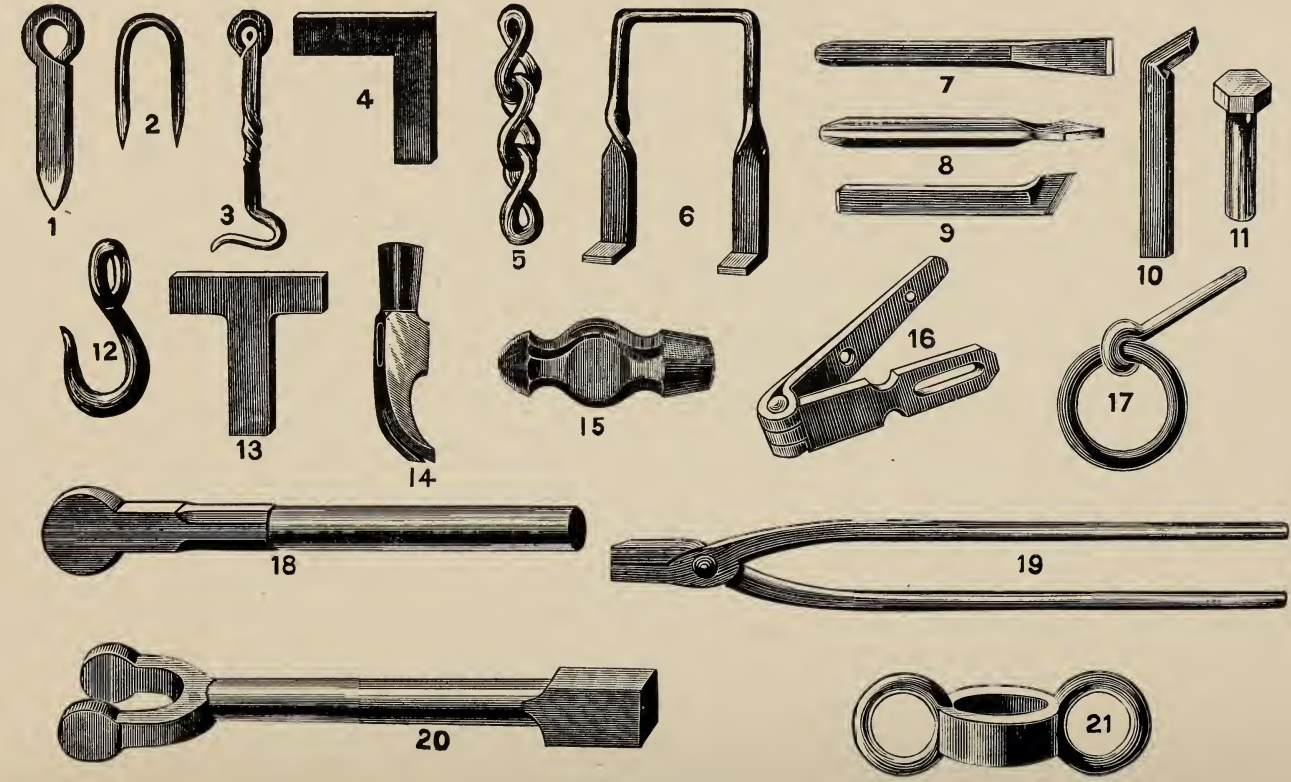
Oct. 31, at Ellicott City; Polytechnic, 17, Rock Hill College, 0.

Nov. 6, at Walbrook; Polytechnic 10, University School for Boys, 0.

Nov. 14, at Westminster; Polytechnic, 0, W. Md. College 2nd, 0.

Nov. 18, at Walbrook; Polytechnic, 0, City College, 10.

Nov. 26, at Annapolis; Polytechnic, 6, Naval Academy Plebes, 22.



FORGE WORK.

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Minor F. Heiskell,
Robert Hooper,
William S. Hugg,
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P. Charles Nelson,
Flavius J. Pennington,
Richard Piez,
Henry M. Price,
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Howard Harvey,
Walter J. Herrman,
Joseph H. Hooper,
John P. Jefferson,
William Mencke,
William F. Mylander,
Edwin F. Orem,
Edward B. Passano,
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Hanson Robinson,
Robert E. Rodgers,
George H. Sickel,
Washington B. Stanton,
Orlando C. Weeks.
William Johnston, Jr.,

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Robert H. Buschman,
Charles C. Constantine,
Edward P. Cromwell,
Howard Crosby.

John L. Ehrman,
Allyn Field,
Harry M. Ford,
Louis H. Gerding,
Arthur Gordon,
Ernest Griffith,
John S. Hand,
Joseph Isaac,
Claiborne M. James,
Albert C. Layman,
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George W. Moog,
John K. Mount,
Robert W. Peach,
Charles E. Phelps, Jr.,
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Joseph Steifel,
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Carroll Thomas.
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J. Froelich,
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A. O. Robertson,
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Michael D. Schaefer,
William P. Shriver,
Theodore Straus.

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Basil Benson,
William Benson,
William Boucsein,
Morde Bren,
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George Dannettel,
Charles Ehlers,
Ferdinand B. Keidel,
J. Edgar Knipp,
Samuel McNeal,
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Herbert M. Reese,
Edmund W. Robinson,
Reuben Row,
Warren S. Seipp,
Richard S. Warner,
William A. Young.

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B. Harrison Branch,
Leonard Burbank,
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J. W. Dawson, Jr.,
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Charles R. Durling,
Isidor Deutsche,
Walter H. Eisenbrandt,
Frank B. Hooper,
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Louis Liepman,
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C. Raymond Carson,
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Henry M. Fitzhugh,
James F. McShane,
Clarence F. Morfit,
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Louis Mueller,
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Alan P. Wilson,
John Zeubert,
Pliny Cutler Hall,
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Erich Albert Loeser,
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Harold Vincent Patterson,
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Chester Waters Larner,
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Ernest B. Walton,
Arthur S. Weiss,
George K. Yost,
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Joseph T. Henthorn,
John S. Hess,
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William S. Samuel,
G. Forney Shryock,
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(Four Year Course.)

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Robert Dall,
William L. De Baufre,
John K. Flickenschildt,
Walter M. Gieske,
Donald S. Hays,
John S. Hess,
I. Seeley Jones,
LeRoy M. Langrall,
H. Quimby Layman.

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James B. Jones,
Milton Kraemer,
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Arthur B. Marston,
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